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BULLETIN No. 377

DECEMBER, 1934

**The Maine
Agricultural Experiment
Station
ORONO**

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Summary Report of Progress, 1934



AROOSTOOK FARM, PRESQUE ISLE, MAINE

FINANCIAL STATEMENT
**For the Fiscal Year Ending
June 30, 1934**

UNIVERSITY OF MAINE
**THE MAINE AGRICULTURAL EXPERIMENT STATION
ORONO, MAINE**

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CONTENTS

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	PAGE
Potatoes	323
Organization and management of potato farms in	
central Maine.....	323
Farm capital.....	323
Farm receipts.....	324
Farm expenses.....	324
Farm profits.....	324
Farm acreage.....	325
Livestock	325
Tractive power	325
Farm crops.....	325
Cultural practices in relation to yield of potatoes per acre	326
Various factors in relation to labor income.....	327
Organization and management of potato farms in	
Aroostook County, Maine.....	328
Costs and returns in producing potatoes in Maine.....	329
Presque Isle area, 1928 crop.....	329
Houlton area, 1928 crop.....	331
Certified seed-potato farms in Aroostook County,	
1928 crop.....	332
Motive power on Maine potato farms.....	332
Fertilizer experiments with potatoes.....	334
Permanent plots.....	334
Magnesium deficiency studies.....	336
Potash-magnesium test.....	336
Uncommon-element test on potatoes.....	337
Acid-neutral fertilizer test on potatoes.....	337
Fertilizer placement studies on potatoes.....	338
Spraying and dusting of potatoes.....	338
Comparison of different spray schedules.....	339
Spray service.....	340
Comparison of two vs. three nozzles per row in spraying	341
Different amounts of lime in Bordeaux mixture.....	342
High-magnesium lime vs. high-calcium lime in	
Bordeaux mixture.....	342
Comparison of different spray fungicides.....	346

Bordeaux mixture compared with copper lime dust and basic copper lime dust.....	347
Degeneration diseases of potatoes.....	348
Latent mosaic.....	348
Natural dissemination of virus diseases in north- eastern Maine.....	348
Seed plots in northeastern Maine.....	349
Seed plots and aster cages in southwestern Maine.....	350
Insects in relation to the transmission of virus diseases of potatoes.....	351
Control of flea-beetles on potatoes.....	353
Wireworm injury to potatoes.....	354
Distribution of new seedling varieties of potatoes.....	356
Yield comparisons between Green Mountain, Giant Hill, and Rust Proof.....	356
Comparison of Green Mountain potato tuber lines.....	358
Reduction in stand of potatoes by seed piece rot.....	358
Cooking quality of potatoes.....	360
Dairying	360
An economic study of the dairy industry in Maine.....	360
The effect of the depression on the income from Maine dairy farms.....	361
Factors responsible for decreased income.....	363
Adjustments made by Maine dairymen.....	364
Extent to which Maine and other New England dairy- men have controlled milk production.....	365
Animal breeding and nutrition.....	367
Nutritional deficiency diseases.....	367
The formulation of superior rations for high-producing animals	368
The uropygial gland of birds and vitamin D assimilation..	369
Determining the time of embryonic mortality, from the position of the embryo (domestic fowl).....	370
Apples	374
Breeding new varieties of apples.....	374
Apple pollination studies	375
Apple tree shape in relation to yield and growth.....	375
Apple fruit fly or railroad worm.....	375
Control	375

Life history studies.....	376
Emergence of adult flies.....	378
Electric light traps for combating apple insects.....	380
Apple scab control.....	381
Small McIntosh trees.....	381
Golden Delicious trees.....	383
Small fruits.....	384
Strawberry variety tests.....	384
Red raspberry variety test.....	385
Grape variety test.....	385
Blueberry investigations.....	386
Selection and variety testing.....	386
Field management of the blueberry.....	386
Fertilizers for the blueberry.....	386
Weed control in blueberry fields.....	386
Sweet-fern control in blueberry fields.....	388
Diseases of the blueberry.....	389
Canning crops.....	391
Sweet corn.....	391
Breeding investigations.....	391
Fertilizer and lime tests with sweet corn.....	392
Bacterial wilt of sweet corn.....	393
Resistance studies.....	394
General occurrence of bacterial wilt.....	394
Field beans.....	395
Variety tests.....	395
Old fashioned yellow eye.....	395
Red kidney.....	396
Pea beans.....	396
Fertilizer and lime tests with beans.....	396
Snap beans.....	397
Garden crops.....	397
Lettuce variety tests and hay mulch tests.....	397
Tomatoes.....	398
Variety tests and breeding.....	398
Cucumbers.....	399
Breeding studies.....	399
Rutabagas.....	400
Control of water heart in rutabagas.....	400

Aphid investigations.....	401
Aphid investigation with special reference to the range of food plants.....	401
Wheat wireworms	401
Wireworms in Maine soils.....	401
Life history and control of the wheat wireworm.....	403
Nutrition of children in Maine.....	405
A study of food habits and the nutritional status of children in selected communities in Maine.....	405
Family financing of higher education.....	407
A study of the financing by Maine families of the higher education of their children in Maine institutions.....	407
Electrical cookery.....	407
Market area studies.....	409
Local market conditions and requirements of agricultural products in Maine (except Aroostook County).....	409
Farm credit in Maine.....	410
Agricultural credit in Maine.....	410
Chemistry investigations	411
Inspections service.....	412
Food and drug inspection.....	412
Testing of dairy glassware.....	412
Feeding stuffs inspection	412
Fertilizer inspection	412
Inspection of agricultural seeds, insecticides and fungicides	412
Gasoline and motor oil inspection.....	413
Gasoline	413
Motor oil.....	413
Announcements	414
Projects for 1934.....	414
Publications	417
Meteorological observations.....	423
Report on the finances of the Station.....	425

BULLETIN 377

INTRODUCTION

The work of the Station for the calendar year 1934 is reviewed briefly in this bulletin. Whenever conclusive evidence has been obtained in any line of investigation the results are published in more detail elsewhere. The reports here given are for one year only and indicate the progress being made in the various studies.

POTATOES

ORGANIZATION AND MANAGEMENT OF POTATO FARMS IN CENTRAL MAINE. William E. Schrumpf. The area in central Maine in which this study was made includes a section of southern Piscataquis County, a section of eastern Somerset County, and a section of western Penobscot County, where the boundaries of the three counties join.

Through personal interviews with potato producers, information was obtained on each of 38 farms for the two years beginning April 1, 1929 and 1930. This information covered the entire farm business, with special emphasis on the production and disposal of the potato crop.

The subject matter included farm capital, farm receipts, farm expenses, farm profits, farm acreage, livestock, tractive power, farm crops, cultural practices in relation to yield of potatoes per acre, and the relationships between labor income and such factors as size of farm, production rates, use of labor, use of capital, and farm balance.

Farm Capital

Average yearly capital of the central Maine farms for the two years was \$12,478 per farm. Of this amount 73.9 per cent was in real estate, 11.9 per cent in machinery, 9.6 per cent in livestock, and 4.6 per cent in feeds and supplies.

Farm capital in real estate averaged \$9,228, of which 47.1 per cent was in buildings and 52.9 per cent in land. The investment in buildings was \$4,350 per farm, 45.8 per cent of which was in dwellings, 40.0 per cent in barns, and the remainder in tool sheds,

garages, and other buildings. The land was valued at \$4,878 per farm. Of this value 61.3 per cent was in crop land, 21.8 per cent in woodland, and 16.9 per cent in pasture land.

Farm Receipts

Yearly farm receipts averaged \$7,320 per farm for the two years. Receipts from sales of crops were 77.5 per cent and from livestock and livestock products 13.4 per cent of the total farm receipts. Sales of potatoes accounted for 94.2 per cent of the total crop receipts which were \$5,671 per farm. Sales of hay, canning peas, dry beans, grain, sweet corn, and canning beans accounted for practically all of the remaining crop receipts. Crop receipts in 1929 were 12 per cent larger than in 1930.

Farm Expenses

Annual expenses per farm averaged \$5,010. Almost half of these expenses were for labor and fertilizer. The expense for labor was 24.0 per cent and for fertilizer 22.9 per cent of the total farm expenses. Expenses incurred in connection with farm machines, such as the purchase of new machinery, machinery hire, repairs, fuel, and farm use of automobile amounted to 16.8 per cent of the total. The combined expense of livestock purchased, feed for stock, feed grinding, and veterinary service was 10.6 per cent of the total. Expense for seed potatoes, spray and dust material, potato hauling and storage, barrels and sacks together amounted to 10 per cent of the total. Expense for taxes was 4.3 per cent of the total.

Farm Profits

Farm income (the difference between farm receipts and farm expenses) averaged \$2,310 per farm per year. In 1929 farm income was more than twice as large as in 1930, \$3,263 compared with \$1,358.

Labor income (computed by subtracting 5 per cent interest on average capital from farm income) averaged \$1,686 per farm annually. Labor income was \$2,644 per farm in 1929 and \$730 per farm in 1930.

Return on capital was obtained by subtracting the operator's estimate of the value of his time from farm expenses. The yearly

average return per farm on capital was 8.9 per cent. The return on average capital was \$2,064 per farm in 1929 and \$168 per farm in 1930.

Farm Acreage

The average size of farm was 270 acres. Of this area 39.3 per cent was in woodland not pastured, 29.6 per cent in crop land, 22.2 per cent in woodland pastured, 5.9 per cent in open pasture, and 3 per cent in farmsteads and roads.

Livestock

The average numbers of livestock per farm were 4.8 cows, 4.4 heifers and calves, 0.4 bull, 0.3 beef animal, 0.3 driving horse, 2.8 work horses, 13.3 sheep, 1.7 hogs, 38.8 hens, and 0.4 hive of bees.

Tractive Power

Tractive power includes work horses, tractors, and trucks. The number of horses and the number of tractors, other than the general-purpose type, decreased during the two years, while the number of general-purpose tractors and the number of trucks increased. The number of work horses decreased 13 per cent and the number of tractors other than general purpose decreased 28 per cent. There was one general-purpose tractor for the 38 farms studied at the beginning of the two-year period. At the end of the period there were 11 tractors of this type. The number of trucks increased nearly 50 per cent.

Farm Crops

Of the 80 acres of crop land per farm, 45.1 per cent was in hay, 31.2 per cent in potatoes, and 17.5 per cent in oats. Practically all of the remaining crop land was in field beans, canning peas, sweet corn, and canning beans.

The yearly average yield of potatoes per acre was 96 barrels, of oats 44 bushels, of hay 1.1 tons, of dry beans 18 bushels, and of canning peas 2,322 pounds.

The average price received for potatoes was \$2.66 per barrel, for oats 72 cents per bushel, for hay \$10.68 per ton, and for dry beans \$4.44 per bushel. Of the canning crops, beans brought 2.88 cents, sweet corn 3.25 cents, and peas 3.50 cents per pound.

The yearly average production of potatoes was 2,419 barrels per farm, 87 per cent of which were sold. The production of grain per farm was 604 bushels, of which 12.9 per cent were sold. The average production of hay was 40 tons, of which 15 per cent were sold.

About 97 per cent of the total receipts from potatoes came from sales of the Green Mountain variety. About 2.4 per cent of the sales were of the Cobbler variety.

Potatoes sold as table stock constituted about 82 per cent of the potatoes utilized. About 9 per cent were sold for seed, 5 per cent saved for planting, and 3 per cent fed to stock. The remaining one per cent included those used by the family and sold for starch.

Commercial fertilizer was applied to potatoes, other hoed crops, and grain. All of the potato acreage was fertilized and the rate was one ton per acre. Slightly more than 57 per cent of the other hoed crops were fertilized. The average application per acre of fertilizer to other hoed crops was one-half ton. Nearly 20 per cent of the grain acreage received applications of fertilizers and the rate was 0.2 ton per acre.

The fertilizer in most common use for potatoes was the 5-8-7 formula. The 5-7-10 formula ranked second. Following these came the 5-8-10 formula, 4-6-10 formula, and the 10-16-14 formula. The proportion of total tons used that were of the 5-7-10, 5-8-10, and 10-16-14 was much larger in 1930 than in 1929.

Cultural Practices in Relation to Yield of Potatoes per Acre

In both 1929 and 1930 the use of certified seed was associated with larger yields of potatoes per acre than was the use of selected seed, and selected seed with larger yields than common seed. The average yield with certified seed was 102 barrels per acre, with selected seed 98 barrels, and with common seed 88 barrels.

Seed treated, prior to planting, for the prevention of disease was associated with larger yields of potatoes per acre than seed not treated. However, a larger proportion of certified seed received treatment than either selected or common seed.

An average of 6 applications of fungicides per acre per season was associated with yields only slightly larger than an average of 4 applications.

The number of pounds of plant food applied per acre in commercial fertilizer was related to the yield of potatoes per acre. Fields in which the average application was 432 pounds per acre yielded 100 barrels, while the fields which received an average of 376 pounds yielded 94 barrels per acre.

Soil organic matter was significantly associated with yield of potatoes per acre. Fields on which barnyard manure was used had an average yield of 100 barrels per acre compared with 94 barrels per acre for fields on which no manure was used. The average rate where applied was 6.7 tons of manure per acre.

Green manure crops appeared to be more important than barnyard manure in relation to yield of potatoes. The average yield from fields on which no green manure crops were plowed under for potatoes was 95 barrels per acre. In comparison, the yield from fields having green manure crops averaged 108 barrels per acre. This increase in yield occurred in spite of the fact that the potatoes for which green manure crops were plowed under received smaller applications of commercial fertilizer than the potatoes from which green manure crops were omitted.

Various Factors in Relation to Labor Income

Size of farm business, production rates, work efficiency, use of capital, and farm balance was each related to labor income.

Large size of farm business was associated with large labor income in each of the two years. A group of 14 farms having 766 productive-man-work units per farm averaged \$2,738 labor income annually. In comparison, a group of 24 farms having 368 productive-man-work units per farm averaged \$1,073 labor income. Productive-man-work units express the amount of productive work accomplished on a farm on the basis of the average amount of work required for the various farm enterprises in the region in question.

High crop yields also were associated with large labor incomes. The 19 farms having an average yearly crop index of 114 had a labor income of \$2,219 per farm. In comparison, 19 farms having an average crop index of 84 had \$1,154 labor income. Crop index expresses the yield of all crops on a farm in percentage of the average yields of the region in question.

Farms on which labor was used most efficiently returned the largest average labor income. A group of farms averaging 293 productive-man-work units per man returned \$1,963. In comparison, a group averaging 197 productive-man-work units per man returned \$1,485 per farm.

Value of potato machinery per acre of potatoes is one measure of the use of capital. In general, farms having the smallest investment in potato machinery per acre of potatoes had the largest labor income. A group of farms averaging \$27 of machinery per acre of potatoes had \$2,156 average yearly labor income. In comparison, a group having \$46 of machinery per acre of potatoes had \$966 average labor income.

Farms 5 per cent above the average of all farms in the three factors, size of farm business, yield of potatoes per acre, and efficiency in the use of man labor, returned a labor income averaging \$4,486 compared with \$1,686, the average labor income of all farms.



FIG. 41. Farmers of Aroostook County take an active interest in the annual Field Day exercises at Aroostook Farm.

ORGANIZATION AND MANAGEMENT OF POTATO FARMS IN AROOSTOOK COUNTY, MAINE. William E. Schrumpf. This study was reported briefly in Maine Agricultural Experiment Station Bulletin 369, "Summary Report of Progress, 1933." The results

of this study are now in manuscript form and will be available soon as a Station publication.

COSTS AND RETURNS IN PRODUCING POTATOES IN MAINE. William F. Schrupf. Material for this study was obtained by the survey method on 120 potato farms in the Presque Isle area and on 45 farms in the Houlton area of Aroostook County for the three years beginning April 1, 1928, 1929, and 1930; also on 38 central Maine farms for the two years beginning April 1, 1929 and 1930.

Tentative costs of growing, harvesting and storing, and marketing the crop have been compiled for 1928. Summaries of costs and returns for farms producing table-stock potatoes and for those primarily producing certified seed have been prepared.

Presque Isle Area, 1928 Crop

Up to the time of digging on the 101 farms producing table-stock potatoes in the Presque Isle area, 39.5 hours of man labor, 49.1 hours of horse labor, 1.8 hours of tractor use and 0.3 hour of truck use were expended per acre. Costs for labor, power, and equipment, including use of automobile, were \$36.54 per acre. Seed, seed treatment material, fertilizer, barnyard manure, green manure crops, spray and dust materials, use of land, interest on growing costs, and miscellaneous costs, together amounted to \$72.14 per acre. The total cost per acre of growing table stock in the Presque Isle area was \$108.68 of which about one-third was for labor, power, and equipment. The yield of potatoes was 109 barrels per acre and the average cost up to digging was \$1.00 per barrel.

Digging and hauling potatoes from the fields to farm storage and to sidings for storage or sale, and care of potatoes in storage, required 29.2 hours of man labor, 15.3 hours of horse labor, 0.3 hour of tractor use, and 1.5 hours of truck use per acre. Costs of labor, power, and equipment were \$26.08 per acre of production. Farm and track storage, insurance and interest on stored potatoes, shrinkage and miscellaneous costs amounted to \$13.23 per acre. The total cost of digging, hauling, and storing potatoes was \$39.31 per acre or 36 cents per barrel.

Marketing stored potatoes includes hauling from storage as well as grading potatoes and loading them into cars. Comparatively few of the producers of table stock graded and loaded their own potatoes. In marketing potatoes 12.3 hours of man labor, 15.1 hours

of horse labor, and 0.3 hour of truck use were expended per acre of potatoes produced. The total cost for labor, equipment, and miscellaneous costs of marketing potatoes was \$9.49 per acre or 9 cents per barrel produced.

A summary of costs and returns in producing potatoes on table-stock potato farms in the Presque Isle area in 1928 is shown in Table 1. For each acre of potatoes produced, 92 barrels were sold and 9 barrels were used on the farm. The value of these 101 barrels was \$92.44. The total cost of growing, harvesting and storing, and marketing was \$157.48 per acre. There was a loss of \$65.04 per acre produced. Returns per hour of man labor were minus 37 cents and returns per barrel of potatoes produced were minus 60 cents.

TABLE 1

Summary of Costs and Returns in Producing Potatoes on 101 Table-Stock Potato Farms in the Presque Isle Area of Aroostook County, Maine (1928 Crop)

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	3,492	92 barrels	85.18
Potatoes used on farm	298	9 barrels	7.26
Total	3,790	101 barrels	92.44
Costs:			
Growing	4,456		108.68
Harvesting and storing	1,612		39.31
Marketing	389		9.49
Total	6,457		157.48
Profit	-2,667		- 65.04
Man labor cost	1,449	81.0 hours	35.35
Cost of land use	298		7.28
Returns to man labor	-1,218		- 29.69
Returns for use of land	-2,369		- 57.76
Returns per hour of man labor	- .37		
Returns per barrel of potatoes produced	- .60		

Houlton Area, 1928 Crop

In the Houlton area the costs of growing potatoes on the 43 table-stock potato farms were higher than in the Presque Isle area. The extra costs were largely for man, power, and equipment charges which amounted to \$40.82 per acre. The total cost of growing potatoes in the Houlton area was \$110.30 per acre. The yield per acre was 98 barrels and the growing cost was \$1.12 per barrel.

About 71 per cent of the cost of digging, hauling, and storing potatoes in the Houlton area was for labor, power, and equipment compared with 66 per cent for these items in the Presque Isle area. Total harvesting and storing costs in the Houlton area were \$37.11 per acre or 38 cents per barrel produced.

TABLE 2

Summary of Costs and Returns in Producing Potatoes on 43 Table-Stock Potato Farms in the Houlton Area of Aroostook County, Maine (1928 Crop)

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	2,296	81 barrels	76.55
Potatoes used on farm	252	11 barrels	8.39
Total	2,548	92 barrels	84.94
Costs:			
Growing	3,309		110.30
Harvesting and storing	1,113		37.11
Marketing	293		9.76
Total	4,715		157.17
Profit	-2,167		- 72.23
Man labor cost	1,051	88.5 hours	35.04
Cost of land use	160		5.33
Returns to man labor	-1,116		- 37.19
Returns for use of land	-2,007		- 66.90
Returns per hour of man labor	- .42		
Returns per barrel of potatoes produced	- .74		

Less man labor and horse labor were expended in marketing stored potatoes in the Houlton area than in the Presque Isle area. The marketing cost for the Houlton area was \$9.76 per acre of potatoes produced.

There were 81 barrels of potatoes sold and 11 barrels used on the farm for each acre of production in the Houlton area. Value of potatoes sold and used was \$84.94 per acre. The total growing, harvesting and storing, and marketing cost was \$157.17 per acre. The loss per acre was \$72.23. Returns per hour of man labor were minus 42 cents and returns per barrel of potatoes produced were minus 74 cents (Table 2).

Certified Seed-Potato Farms in Aroostook County, 1928 Crop

The total growing cost per acre of potatoes on the 21 certified seed farms was larger than the cost on the table-stock farms. On the certified seed farms the growing cost amounted to \$129.16 per acre. The yield of potatoes was 124 barrels per acre and the cost per barrel was \$1.04.

The costs of digging, hauling, and storing potatoes on the certified seed farms were also larger than on the table-stock farms, the total being \$49.62 per acre or 40 cents per barrel produced.

Marketing costs on the certified seed farms also exceeded marketing costs on the table-stock farms. Marketing costs on the certified seed farms amounted to \$21.02 per acre or 17 cents per barrel produced.

On the certified seed farms 106 barrels were sold and 10 barrels were used on the farm for each acre produced. The value of potatoes sold and used was \$145.67 per acre. Total cost of production was \$199.80 per acre. There was a loss on these farms of \$54.13 per acre of potatoes produced. Returns for man labor were minus 8 cents per hour, and returns per barrel of potatoes produced were minus 44 cents (Table 3).

The average acreage of potatoes produced on these farms was 50 acres of which 39 acres were certified.

MOTIVE POWER ON MAINE POTATO FARMS. William E. Schrumpf. This study has for its objective the determination of (1) the total and comparative use of the different units of farm motive power and accompanying farm machinery for the various farm operations, (2) the duration of usefulness and the total and

comparative costs of operating the farm motive power, and (3) the most efficient combinations of motive power and labor for farms of various sizes and conditions.

TABLE 3

Summary of Costs and Returns in Producing Potatoes on 21 Certified Seed-Potato Farms in Aroostook County, Maine (1928 Crop)

	Average per farm	Average per acre of potatoes	
		Amount	Value
	dollars		dollars
Returns:			
Potatoes sold	6,736	106 barrels	134.71
Potatoes used on farm	548	10 barrels	10.96
Total	7,284	116 barrels	145.67
Costs:			
Growing	6,458		129.16
Harvesting and storing	2,481		49.62
Marketing	1,051		21.02
Total	9,990		199.80
Profit	-2,706		- 54.13
Man labor cost	2,274	105.2 hours	45.48
Cost of land use	474		9.48
Returns to man labor	- 432		+ 8.65
Returns for use of land	-2,232		- 44.65
Returns per hour of man labor	- .08		
Returns per barrel of potatoes produced	- .44		

In addition to the information concerning motive power and equipment obtained for the years 1928, 1929, and 1930 on Maine potato farms, material was secured during the summer of 1934 on 160 farms in Aroostook County as follows:

1. Description of the farms, including total acres, kinds and acres of crops, kinds and numbers of livestock, topography, soil, number and size of fields, distance from shipping point, and kinds of roads.

2. Kinds and value of farm motive power including horses, tractors, trucks, automobiles, stationary gas engines, and electric motors.

3. Kinds and value of farm machinery.

4. Kinds and amounts of work done by each unit of motive power with the accompanying man labor both for the farm and for hire.

5. Cost of operation including such items as labor; feed, care and shoeing of horses; fuel, lubrication, care and repair of tractors, trucks, stationary gas engines, and electric motors; general items of depreciation, insurance, taxes, and housing; and all other costs.

The material for this study has been checked and is in process of tabulation.

FERTILIZER EXPERIMENTS WITH POTATOES. *Permanent Plots.* Joseph A. Chucka and Delmar B. Lovejoy. As a result of the unusually favorable growing season of 1934, all fertilizer treatments on the permanent plots produced higher yields than usual. This favorable growing season also resulted in greater differences in yield among the various treatments. In the rate of fertilizer application studies on the three-year rotation (oats-clover-potatoes) the following results were obtained:

TABLE 4

*Effect of Rate of Fertilizer Application on
Potato Yields*

Treatment	Acre yield	
	Bushels	Barrels
No fertilizer	140	51
1,500 lbs. 4-8-7	338	141
2,000 " "	436	159
2,500 " "	455	165
3,000 " "	492	179

The increase in yield of 108 barrels per acre from 2,000 pounds of fertilizer, and the increase in yield of 128 barrels per acre from 3,000 pounds of fertilizer as compared with no fertilizer

is somewhat larger than the increase obtained from these treatments in the past.

The 1934 results again indicate that of the three primary fertilizer constituents phosphoric acid is the least important, potash is the most important, and nitrogen is intermediate, in determining potato yields. This is indicated by the reduction in yield obtained by leaving nitrogen, phosphoric acid, or potash out of fertilizer mixtures and also by the increase in yield when an excess of any one of these is added in fertilizer mixtures. Compared with the yield (158 barrels per acre) obtained with a ton per acre of a 4-8-7 fertilizer, the reductions in yield resulting from leaving out nitrogen, phosphoric acid, or potash from the fertilizer mixture were 44, 24, and 108 barrels per acre respectively. Increasing the nitrogen from 80 to 120, phosphoric acid from 160 to 240, or potash

TABLE 5

Effect of Organic Matter on Potato Yields

Treatment ¹	Acre yield	
	Bushels	Barrels
Stubble only ²	411	149
One green manuring crop	450	164
Two green manuring crops	493	179
One green manuring crop plus 6 tons straw	537	195
One green manuring crop plus 20 tons manure	567	206

¹ Each of the plots received 2,000 pounds of 4-8-7 fertilizer. The green manuring crop used was a mixture of oats, peas, and vetch.

² The green manuring crop grown on this plot was cut and placed on plot three which therefore had two crops plowed under.

TABLE 6

Effect of Manure on Potato Yields

Treatment	Acre yield	
	Bushels	Barrels
2,000 lbs. 4-8-7	359	131
2,000 lbs. 4-8-7 plus 20 tons manure	533	194

from 140 to 280 pounds per acre in potato fertilizers increased potato yields by 14, 1, and 25 barrels per acre respectively during the past year. These increases in yield from increasing nitrogen and potash are somewhat greater than those obtained during the last few years when growing conditions were less favorable.

The effect of soil organic matter on potato yields was particularly great this year as indicated by the results in Tables 5 and 6.

The results presented in Table 5 were obtained on the two-year rotation series of the permanent plots while those in Table 6 were obtained on the permanent plots cropped continuously to potatoes. Although part of the increase in yield, resulting from the green manuring crop, the straw or the manure, was very probably due to the nutrient elements added in these treatments, it is believed that by far most of the increase was due to the beneficial effects of the organic matter on the soil.

Magnesium Deficiency Studies. Joseph A. Chucka and Delmar B. Lovejoy. A study of the effect of magnesium in potato fertilizers was continued on fourteen different farms in Aroostook County. The results obtained are in general similar to those obtained in the past with the exception that dolomitic limestone as a source of magnesium in potato fertilizers made a better showing than it did in other years. This year dolomitic limestone was about as effective as more soluble sources of magnesium such as kieserite or double sulphate of potash-magnesia. The long favorable growing season may be the explanation for the good results obtained with dolomitic limestone this year.

When potato fertilizers containing various proportions of potash were used both with and without magnesium it was observed that the increases in yield due to added magnesium were greater with fertilizers either lower or higher in potash than with fertilizers containing seven per cent potash. This appears to indicate some relationship between potash utilization and the magnesium content of the fertilizer.

Potash-Magnesium Test. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. A comparison of 4-8-3, 4-8-5, 4-8-7, 4-8-10, and 4-8-12 fertilizers both with and without added magnesium was made on three different farms in Aroostook County. Considering only the average results from

the three farms, the 4-8-10 fertilizer produced the highest yield in the series without magnesium and the 4-8-12 fertilizer produced the highest yield in the series with added magnesium. The increases in yield due to magnesium were greater with both low and high potash than with medium potash.

Uncommon-Element Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. The study of the effect of small amounts of manganese, copper, iron, zinc, and nickel in potato fertilizers was continued as carried on in the past two years. The results indicate that some of these elements may have stimulating effects under certain conditions but may also have depressing effects under other conditions.

Acid-Neutral Fertilizer Test on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry. It is generally known that commercial fertilizers influence soil reaction. Whether this effect is acidic or basic is determined very largely by the sources of nitrogen and by the amount of limestone used in making up the fertilizers. During the last ten or fifteen years increasing amounts of ammonium sulfate and other ammonium compounds have been used to furnish the nitrogen of commercial fertilizers with the result that the residual effect of fertilizers has been increasingly acidic. Thus in areas like Aroostook County where large amounts of fertilizer have been used the soils have become strongly acid, unless limed at regular intervals. Recently some fertilizer companies are attempting to neutralize this acidic effect of fertilizers by the addition of limestone to the fertilizers. There is some question as to whether or not it is advisable to have potato fertilizers contain limestone. Thus it seemed advisable to get some experimental data on this problem. Consequently potato fertilizers with varying degrees of residual acidity were compared with similar fertilizers neutralized with either dolomitic or calcium limestone. This acid *vs.* neutral fertilizer test was placed on three different farms in Aroostook County. Although no definite conclusions should be drawn from the one year's data, it may be said that the 1934 results indicate no superiority of neutral over acid potato fertilizers under the conditions of the test. Further work on this problem needs to be done

before it will be possible to say whether the residual acidity of potato fertilizers can be neutralized by the addition of limestone to the fertilizer or whether it will be necessary to neutralize this acidity by making separate applications of limestone to the soils upon which acid fertilizers are used.

Fertilizer Placement Studies on Potatoes. Joseph A. Chucka and Delmar B. Lovejoy, in coöperation with Bailey E. Brown of Soil Fertility Investigations, U. S. Bureau of Plant Industry and G. A. Cumings, U. S. Bureau of Agricultural Engineering. In the 1934 fertilizer placement studies on potatoes the procedure followed was essentially the same as that used in the two preceding years. Eight different fertilizer placements were employed both with single and with double strength fertilizers.

The results obtained this year indicate more strikingly than ever the importance of placement of fertilizer in determining potato yields. The range in yield between the poorest and best placement was 53 barrels per acre with single strength fertilizer and 46 barrels per acre with double strength fertilizer. With both single and double strength fertilizers the highest yield (212 barrels per acre for single strength and 211 barrels per acre for double strength) was obtained with a placement in which the fertilizer was placed in narrow bands two inches to each side and slightly below the seed pieces. The single strength fertilizer gave the lowest yield (159 barrels per acre) when mixed thoroughly with the soil below the seed pieces. The double strength fertilizer gave the lowest yield (165 barrels per acre) when placed in a 4 to 5 inch band about one inch below the seed pieces.

Since the placement (in narrow bands two inches on each side and slightly below the seed pieces) which gives the best results may very easily be secured with most of the modern planters, potato growers should take advantage of this information and adjust their planters so as to get the most efficient use of the fertilizer used.

SPRAYING AND DUSTING OF POTATOES. Reiner Bonde. Late blight or "rust" was not abundant in Aroostook County in 1933. It was thought by some that several seasons would be required in order to build up an abundance of infection in the potato seed stock. Blight was, however, discovered in the vicinity of Easton the latter part of July in 1934 and caused considerable loss in a

few rather localized areas. Toward the end of the season the disease was sparsely distributed throughout the potato growing area of northern Aroostook County. In a few cases a considerable amount of loss due to rot was reported. The disease undoubtedly would have become generally severe, with greater losses resulting, if the weather had not been dry at critical times.

This information is important because it shows that a "rust" epidemic may occur following a season with little or practically no disease. It is of interest that the disease was practically absent on Aroostook Farm except where artificially introduced for experimental purposes.

Comparison of Different Spray Schedules. Previous yield tests have shown that the spray applications made late in the season may be essential for the control of late blight. This is likely to be the case during seasons when rust is abundant.

The question has often arisen as to whether flea beetle injury early in the season, while the plants were young, did not affect the yield. Some growers spray early to avoid this injury. Experiments to date have, however, indicated that early spraying usually is of relatively little benefit to the Maine growers.

The relative value of different times of applying spray to potatoes was studied in more detail in 1934. In this test four schedules were followed. One series of plots received eight applications, beginning early in the season, while the foliage was quite small, and continuing until late. Another series of plots received six applications beginning early but omitting the two last applications for the season. This is the practice often followed by farmers in Aroostook County. The third series of plots followed the delayed spray program. The two earliest applications were omitted and spraying was continued until late in the season. The fourth schedule received only four spray applications for the season. In this plan both the two earliest and the two latest applications were omitted.

In these tests the yields varied from 167 to 173 barrels an acre and no significant differences were found between the different spray schedules with respect to yield. The plots receiving the regular spray schedule of eight applications yielded slightly less than the other series. Further, in a nearby series of plots, non-sprayed controls gave slightly better yields than adjacent plots

sprayed with Bordeaux. The data for 1934 are, however, not representative of the average season in Aroostook County and should not be used as a basis on which to adopt a standard spray schedule. Little rust was present in the experimental plots, a fact which explains why the late spray applications proved to be of no benefit. The applications were also made with a three-nozzle (per row) boom which applied from 125 to 135 gallons per acre per application. It is possible that the use of this more modern spray rig, carrying more power and using more spray material than a lower powered sprayer with only two nozzles per row, made the late spray applications less essential than usual.

Spray Service. The potato spray service was continued in 1934 as in previous years. This service is under the direction of the local Farm Bureau and is aided by the Experiment Station workers located on Aroostook Farm at Presque Isle.

The farm coöperators enrolled in this project receive notices through the mail telling them each time it is planned to spray on Aroostook Farm. The growers also receive timely spray warnings informing them when "rust" first appears in Aroostook County and also information regarding the prevalence of the disease and the occurrence of weather conditions which favor its rapid spread.

At various times during the summer, the local newspapers are given data and information regarding the subject of plant disease control, which are disseminated among the numerous readers in the County.

The spray service has gained rapidly in popularity as can be seen by the steady growth in the number of growers who were enrolled as coöperators in the project for the past four years:

Year	Number of coöperators enrolled
1931	81
1932	347
1933	2,410
1934	3,006

This project is performing a needed service to the growers of Aroostook County. The growers receive timely information regarding their spraying problems which often affords great eco-

monic savings. The service has made the problem of potato spraying a more generally discussed subject among growers. This added interest and discussion has been of great educational value concerning the practical control of potato diseases in Maine. It is helping to make our growers more "spray-minded."

Comparison of Two vs. Three Nozzles Per Row in Spraying. Many farmers have been confronted with the problem whether it is necessary or advisable to use a three-nozzle (per row) boom for spraying potatoes in Aroostook County instead of the more commonly used two-nozzle boom. In 1934, a three-nozzle boom was compared with a two-nozzle boom in a spray test. The same machine was used for both parts of the test. One set of plots was sprayed using three nozzles (per row) consisting of an overhead middle nozzle and two side nozzles. For the other and adjacent set of plots the middle or overhead nozzle was shut off and the two side nozzles adjusted so as to give the maximum amount of foliage coverage.

Six applications were made during the season, the first being made on July 19 and the last on September 1. Approximately 100 gallons of spray was applied per application with the two-nozzle boom and 125 gallons per application with the three-nozzle boom.

The results of these tests are as follows:

Treatment	Yield per acre	
	Barrels	Bushels
Two nozzles per row	177	488
Three nozzles per row	172	472
Difference in yield in favor of two-nozzle boom	5	16

In these tests the three-nozzle boom proved inferior to the two-nozzle boom in spite of (or possibly because of) the fact that it applied a considerably larger amount of spray material. The difference in yield of five barrels per acre is, however, not significant for these data (odds 8 to 1).

Many growers have experienced difficulty in securing good disease control. These growers may possibly have better success if a three-nozzle per row boom is employed. This is especially

true where the delayed spray program is followed or where growers wish to make the minimum number of applications. It is, however, true that many growers can secure better service with their two-nozzle rigs than they now do. Much could be gained by readjusting the position of the nozzles, by timing their spray applications better, and by spraying more often.

Different Amounts of Lime in Bordeaux Mixture. Data secured on Aroostook Farm have indicated that an excess of lime in Bordeaux mixture is detrimental to potato growth and reduces the yield rates.

This past season the effect of reducing the lime content of Bordeaux mixture was studied in more detail in an attempt to gain information pertaining to the problem of spray stimulation. In these tests a standard Bordeaux mixture (10-10-100 formula) was compared with Bordeaux mixture containing half as much lime (10-5-100 formula) and with non-sprayed checks.

The average yields for these comparisons are as follows:

Treatment	Yield rate per acre*		Odds in favor of sprayed treatments
	Bushels	Barrels	
10-10-100	475±4.29	173±3.67	—
10- 5-100	475±4.27	173±3.68	—
Check			
(Non-sprayed)	416±4.82	152±1.38	Very high

* Each yield rate is the average for 23 replicated plots each .04 acre in area.

The data for 1934 did not show yield differences from varying amounts of lime in Bordeaux. There was, however, a great difference between the plots not sprayed and those that were sprayed. This may be explained on the basis that the sprayed plants lived longer. Longer life was due in part to the control of a light rust infection. The difference in favor of the sprayed plots was 59 bushels or 21 barrels. This increase in yield was sufficient to pay for the spraying operation in spite of the prevailing low prices of potatoes.

High-Magnesium Lime vs. High-Calcium Lime in Bordeaux Mixture. Experiments conducted in 1933 demonstrated that Bor-

deaux made with hydrated dolomitic (magnesium-containing) lime is superior to a Bordeaux made with a hydrated calcium lime for the spraying of potatoes growing on certain types of soil. As a direct result of these experiments approximately 1,200 tons of dolomitic spray lime was sold and used in Aroostook in 1934.

In 1934 the effect of applying magnesium to the plants with the regular Bordeaux spray applications was studied in greater detail. The experiments were conducted on two farms in different localities in the County. One experiment was performed on rather poor and over-cropped soil in the vicinity of Caribou, Maine. The other experiment was conducted on Aroostook Farm at Presque Isle on soil that was in a good state of fertility.

On the Caribou plots the Irish Cobbler variety was used. Magnesium (20 pounds MgO per acre) was applied to the soil with the fertilizer at planting time, and also was applied in several different forms in the Bordeaux spray. Hydrated dolomitic lime containing 33 per cent MgO was used because it is a cheap source of magnesium and can be readily used as a substitute for a high-calcium lime in the preparation of Bordeaux mixture. Epsom salts and kieserite were used as additions to the calcium Bordeaux because they are soluble forms of magnesium and readily go into solution with Bordeaux mixture. It was felt that the magnesium in dolomitic lime might not be soluble enough to be most available and of greatest use to the sprayed plants.

The results derived from these experimental plots are summarized in Table 7. They show that a Bordeaux made with a high-calcium lime is decidedly inferior to a dolomitic lime Bordeaux when used for spraying potatoes grown on highly acid and magnesium-deficient soil in Aroostook County. These data are in accordance with the results of 1933 secured from experimental plots under observation in the vicinity of Limestone and Easton.

Epsom salts and kieserite, dissolved and used in the calcium Bordeaux spray, increased the yield above that secured when dolomitic lime was used in Bordeaux. The differences in favor of the Epsom salts and kieserite treatments over the dolomitic lime in these tests, although statistically significant, are however not as great as might be expected. Furthermore, the extra cost of using dolomitic lime was negligible while the Epsom salts and kieserite treatments were quite expensive. In these tests the ad-

ditional cost per acre was only about two cents for using dolomitic lime in place of calcium lime, but was approximately \$4.00 for the Epsom salts, and from \$1.20 to \$1.80 for kieserite.

It is also of great significance that in these tests the plots sprayed with calcium had a much greater percentage of culls and waste tubers than did those plots in which magnesium had been applied in the spray mixture. The plots sprayed with calcium Bordeaux produced approximately 30 per cent culls and the ones to which magnesium was supplied with the spray applications produced only 10 per cent culls.

The soil of the Aroostook Farm tests was more fertile than the soil of the plots at Caribou. On Aroostook Farm the test was conducted on two series of plots. In one series, magnesium was

TABLE 7

Summary of Results Obtained by Applying Different Forms of Magnesium in Bordeaux Spray on a Farm Near Caribou—1934

Spray material used ¹	Dates sprayed ²				Total amount applied for season in pounds per acre		Barrels average yield per acre ³	Increase (bbls.) over calcium sprayed controls
	July 12	July 17	July 25	Aug. 7	Spray material	MgO		
Bordeaux made with hydrated dolomitic lime	XX	XX	XX	XX	40 dolomitic lime	13.2	102	45
Bordeaux made with hydrated calcium lime containing a trace of MgO	XX	XX	XX	XX	40 calcium lime	Trace	57	—
Bordeaux containing 20 pounds Epsom salts per 100 gallons	XX	XX	XX	XX	80 Epsom salts	13.2	112	56
Bordeaux containing 10 pounds kieserite per 100 gallons	XX	XX	XX	XX	40 kieserite	13.14	120	63
Bordeaux containing 20 pounds kieserite per 100 gallons		XX	XX	XX	60 kieserite	19.72	114	57
Bordeaux containing 30 pounds kieserite per 100 gallons			XX	XX	60 kieserite	19.72	111	54

¹ Approximately 100 gallons were applied per acre at each application, as a 10-10-100 Bordeaux mixture. The dolomitic hydrated lime contained 33% MgO, Epsom salts 16.44% MgO, and Kieserite 32.86% MgO.

² On dates indicated by XX, spraying was done with the material indicated in Table 7. On the dates not marked XX the plots were sprayed with calcium-lime Bordeaux.

³ Each yield is based on the average weight of from 17 to 25 replications each containing 33 feet of row.

applied in the fertilizer in addition to that supplied by the spray. In the other series magnesium was not applied in the fertilizer. The Green Mountain potato variety was used in these tests. The results are summarized as follows:

Treatment	Yield per acre in barrels	
	Magnesium in fertilizer	No magnesium in fertilizer
Bordeaux made with dolomitic lime	176	170
Bordeaux made with calcium lime	170	153
Difference in favor of dolomitic lime	6	17

In the tests conducted on Aroostook Farm the plots sprayed with dolomitic Bordeaux mixture yielded more than the plots sprayed with the calcium Bordeaux. The difference was greatest in the series of plots that did not receive magnesium in the fertilizer. The difference of 17 barrels per acre in favor of the dolomitic Bordeaux for the plots not receiving magnesium in the fertilizer is large enough to be considered statistically significant for these data. The dolomitic Bordeaux series of plots also yielded more than the calcium Bordeaux series on the plots that received magnesium in the fertilizer at planting time. Here the increase of six barrels is not highly significant for the data. It would indicate, however, that the amount of magnesium supplied by the fertilizer (20 pounds of MgO per acre) was not sufficient to meet the need of the plant. These results tend to show that it is advisable to use a dolomitic lime for the preparation of Bordeaux even on some of the better soil. The benefits derived from its use on the better soils cannot be expected to be as great as when it is applied on the poorer soils that are deficient in organic matter.

Throughout these experiments, magnesium applied as a spray has made the plants develop a darker green color and continue their growth and retain their foliage for a longer period of time. Epsom salts appeared to be more rapid in producing a recovery from chlorosis. Plots sprayed with this material added to the mixture showed beneficial results within a week after the applica-

tion. Kieserite when applied at the rate of 10 pounds per hundred gallons of Bordeaux was somewhat slower in producing an obvious improvement. The plots sprayed with 10 pounds of kieserite per hundred gallons of Bordeaux, however, gave somewhat the best yield rate as shown in Table 7. Plots sprayed with kieserite used at the rate of 20 and 30 pounds per hundred gallons but applied at later dates, showed beneficial results very soon after the spray was applied.

Dolomitic lime Bordeaux was rather slow in showing a definite benefit in comparison with either Epsom salts or kieserite when applied to chlorotic plants. Toward the latter part of the season, however, the plots sprayed with this material were equal in general appearance to those sprayed with mixtures containing either Epsom salts or kieserite.

These experiments have shown that a Bordeaux mixture prepared with a high-magnesium lime is superior to that prepared with a high-calcium lime on certain kinds of Aroostook soil. On fields showing a considerable amount of chlorosis and lack of vigor due to magnesium hunger, it may prove to be advantageous to apply from 10 to 20 pounds of Epsom salts or kieserite per hundred gallons of Bordeaux mixture. When this is done it would seem the spray applications should be made as early in the season as possible in order to secure the maximum benefits from the magnesium. So far our tests have not brought out any undesirable characteristic of dolomitic lime Bordeaux.

Comparison of Different Spray Fungicides. There is a considerable demand for a spray material that will not paint the potato foliage and leave a visible residue. Bordeaux mixture, especially when it contains an excess of lime, discolors the foliage and makes it difficult to detect the mosaics and other virus diseases. Raleigh (see reports for 1932 and 1933) has developed a home-made colloidal copper spray which has given good rust control and also does not discolor the foliage. Recently a commercially prepared product known as basic copper sulphate has been developed and offered for sale. It does not discolor the foliage and hinder the detection of diseases in the field.

In 1934, colloidal copper, basic copper sulphate, Bordeaux mixture and non-sprayed controls were compared using 10 replicated plots for each treatment. The average yields for these comparisons are as follows:

Treatment	Average yield per acre	
	Bushels	Barrels
Colloidal copper	443±5.20	161±1.90
Basic copper sulphate	458±4.02	167±1.45
Bordeaux mixture	432±5.61	157±2.39
Unsprayed controls	435±3.87	158±1.38

It is of special interest that in these comparisons the plots sprayed with Bordeaux mixture gave somewhat the smallest yields in spite of the fact that they remained green the longest. The non-sprayed controls yielded more than adjacent plots sprayed with Bordeaux mixture. This probably was because disease, especially late blight, was relatively absent in this experiment. The colloidal copper and the basic copper sulphate plots appeared to be somewhat superior as indicated by the yields obtained. These sprays apparently do not cause a retardation of growth and a lagging of the natural date of maturity as seems to be the case with plots sprayed with Bordeaux mixture. This feature is a benefit in seasons of relatively few insects.

Basic copper sulphate has not been given sufficient trials on Aroostook Farm to warrant its recommendation for general use by farmers. This material should be tested under severe rust conditions and insect infestations before it can be considered as a reliable substitute for Bordeaux mixture.

Bordeaux Mixture Compared with Copper Lime Dust and Basic Copper Lime Dust. Many farmers in Aroostook County prefer to apply a dust fungicide instead of Bordeaux mixture to their potatoes. This is true in spite of the fact that the dust treatments have generally been associated with smaller yields than have the Bordeaux sprays in tests on Aroostook Farm. Since the Experiment Station is attempting to discover more efficient spray and dust fungicides for the control of "rust" in Aroostook County, in 1934 basic copper lime dust was compared with standard copper lime dust and with Bordeaux mixture. The basic copper lime dust was prepared by mixing 17.5 pounds of basic copper containing 52 per cent copper with 82.5 pounds of hydrated lime. The dusts were used at the rate of 28 to 32 pounds per acre at each of six applications.

The average yields for these comparisons are as follows:

Treatment	Average yield per acre		Odds
	Bushels	Barrels	
Bordeaux mixture	435±4.14	158±1.57	1 to 1 compared with standard copper lime dust 64 to 1 compared with basic copper lime dust
Standard copper lime dust 9%	429±5.88	156±2.15	7.28 to 1 compared with basic copper lime dust
Basic copper lime dust 9%	410±5.36	149±1.99	

In these tests Bordeaux mixture was slightly superior to either of the dusts used. This difference is, however, not great enough to be considered very significant. Basic copper lime gave slightly inferior yields in these tests. The relative merit of this material can be determined better in a season when disease is more prevalent than it was in 1934.

DEGENERATION DISEASES OF POTATOES. (In coöperation with E. S. Schultz, W. P. Raleigh, F. J. Stevenson, and C. F. Clark, of the Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, United States Department of Agriculture.)

Latent Mosaic. E. S. Schultz, W. P. Raleigh, and Reiner Bonde. A mosaic, or combination of mosaics, that is latent (present without producing noticeable symptoms) in Green Mountain potato plants, is disclosed by inoculations of Jimson weed (*Datura stramonium*) and certain potato varieties. The symptoms differ considerably from one variety to another, and so does the degree of resistance. Resistance in one seedling (41956) was indicated in 1933. Buckthorn aphids (*Aphis abbreviata*) did not transmit latent mosaic from Green Mountains while taking the second and distinguishing component of each of the diseases mild mosaic, leaf-rolling mosaic, rugose mosaic, and streak to a Green Mountain seedling that was free of latent mosaic.

Natural Dissemination of Virus Diseases in Northeastern Maine. Reiner Bonde. On Aroostook Farm the spread of mild mosaic to Green Mountains in 1933 was very general. Records

show that healthy plants grown one row removed from mild mosaic became 43 per cent diseased. At a distance of 15 feet mild mosaic had spread to 30 per cent of the plants. At a distance of 100 feet from infection approximately 17 per cent of the plants had contracted mild mosaic.

Seed plot stock free from mild mosaic in 1933 and grown in an isolated tuber unit seed plot had 1.7 per cent mild mosaic in 1934. This disease evidently had been introduced by migrating insects from a considerable distance, the nearest other potatoes being several hundred feet away.

Leafroll was spread less extensively than mild mosaic in the proximity studies conducted on Aroostook Farm. The progeny of healthy stock grown one row removed from leafroll showed only 3 per cent disease. Leafroll was, however, carried a distance of 200 feet or more, contaminating a disease-free tuber unit seed plot. The Chippewa and Katahdin varieties also readily contracted leafroll in isolated plots but remained free from mosaic due to their resistance.

Most of the spread of mild mosaic occurred late in the season in 1933, as is usual. This spread was largely eliminated by selecting disease-free hills and harvesting them as early in the season as tuber development permitted.

Seed Plots in Northeastern Maine. Donald Folsom. Green Mountain tuber lines were originated and maintained in the open field on Highmoor Farm in southwestern Maine, and in 1933 were planted in 18 plots in Aroostook County under varying conditions. The average area per plot was over an acre. The stocks were replanted in 1934 in fields and the virus-disease content ascertained. Mosaic and leafroll in 1933 had entered the plots or increased in them while yellowtop and spindle tuber had either decreased or remained absent. Mosaic and leafroll had reached higher percentages in the smaller, later planted plots. This was true in spite of the fact that there was less disease and more tuber-unit planting in the smaller, later plots. The abundance of these two diseases in 1934 was greater also with less isolation of the seed plots from diseased potatoes in 1933 and was not affected by the amount of disease inside the plot (rogued as early as possible) in 1933.

Green Mountains grown in the open on Highmoor Farm in 1933 with virus diseases rogued early, were planted by growers

by tuber unit on over ten acres in Aroostook County in 1934. There they were 0.14 per cent mosaic and 0.22 per cent leafroll. An equal amount was planted in bulk (not by tuber units). Although the finding of mosaic in all plots ended their value to us for experimental purposes, the amount of disease was small enough to make this seed stock about as useful to the growers as any obtainable on the seed market.



FIG. 42. One third acre of potatoes under a cloth cage. This is the only means found effective for producing seed for several acres of Green Mountain potatoes entirely free of recognizable virus diseases.

Seed Plots and Aster Cages in Southwestern Maine. Donald Folsom. Green Mountain tuber lines originated and maintained in the open on Highmoor Farm, have become infected by several virus diseases before reaching the two-acre stage in the process of increasing the stock. However, part of one tuber line grown as disease free on one fifth acre under an aster cloth cage was used to plant four acres in 1934 which proved to be entirely free of virus diseases. The crop from these four acres has been placed with seed growers for the season of 1935.

INSECTS IN RELATION TO THE TRANSMISSION OF VIRUS DISEASES OF POTATOES. G. W. Simpson. During the past season the relation of aphids to the transmission of virus diseases of potatoes has been studied along lines much the same as those pursued during the past few years. The investigation has two primary objectives: 1. To locate places where foundation seed stock can be produced by local growers. 2. To discover the conditions necessary in the production of foundation seed stock in Maine. In the course of the work many practical difficulties have been overcome and a fund of significant information is being accumulated. Roguing is done under the supervision of the Department of Plant Pathology. Nine plots in different localities in Aroostook County were under observation during the summer. One of these was located in an area not previously studied with regard to its possibilities for the production of foundation seed stock. One locality which has been under observation for several years was eliminated from the experimental work because of a consistent spread of disease in spite of roguing.

The centers which were found to be more successful in the past continue to yield satisfactory results. In one seed stock first imported into Aroostook County in 1931 and rogued since, mosaic was entirely absent during the past season and less than 0.1 per cent of leafroll was found. This is the first season that this stock has not shown at least a trace of mosaic. In another locality a stock, the history of which is similar to the preceding, is still sufficiently free from mosaic and leafroll to be considered foundation stock.

As a result of the work which has been conducted since 1932, mosaic and leafroll have apparently been eliminated from five different strains of Green Mountains grown in one locality, while in two other locations this result has not been accomplished to date by the means employed.

On one farm the increase from tuber-indexed stock has been maintained free from mosaic through a third season and has now been placed in commercial production. In one lot of this stock planted elsewhere the only disease found during the past summer was two units of leafroll.

Evidence of the spread of mosaic from a field to a seed plot was obtained in two instances. This conclusion is based on the

fact that in 1933 the two plots in question showed only mild mosaic while in 1934, crinkle and rugose mosaic were also rogued. The distance in one case was about 250 feet; in the other more than 700 feet. In both cases the 1933 seed plots were green for some time after the neighboring commercial fields were dead. In both cases also, an increase in the number of peach aphids (*Myzus persicae*) present in the plots was noted shortly after the death of the plants in the commercial fields.

On one farm where a serious infestation of buckthorn aphids (*Aphis abbreviata*) developed in July, it is at least significant to note that more than 75 per cent of the units rogued for mosaic were removed in August. This appears to be strong presumptive evidence of current season infection made possible by the severe aphid infestation. *Aphis abbreviata* was the dominant species in this plot. *Macrosiphum solanifolii* and *Myzus persicae* were found in small numbers in August, but were presumably not present soon enough to have been a factor in the transmission of virus diseases so early in the season.

Aphids were found earlier and the infestation was heavier in plots nearest woods and swamps. These insects appeared later on plots somewhat removed from woods and latest on plots located on cleared uplands. On the other hand, there was more disease in plots on cleared uplands the following year, but this increase can be correlated with late season infestation by aphids and proximity to fields severely infected with disease.

Preliminary experiments indicate that both winged and wingless aphids may be transported by the wind over distances great enough to be of possible significance in the spread of the virus diseases. Because of the importance of this possibility, it is planned to continue studies of the dispersal of aphids by wind.

During the period of migration from the winter to the summer hosts, winged aphids were observed coming to a seed plot, and also flying away presumably after having fed on plants in the plot. The direction of flight seems to be governed largely by the direction of the wind and evidence indicates that the aphids fly with the wind.

During the season of 1933, about ten thousand barrels of seed were produced by growers coöperating with the Experiment Station on this project. Somewhat more than half of this amount is

estimated to have been planted in Aroostook County in the spring of 1934. The balance went into the southern seed trade.



FIG. 43. Small cloth cages that protect potato plants from insects which carry virus diseases (such as mosaic, leafroll, and spindle tuber). Some potato strains have thus been kept healthy in Aroostook County for twenty years. These cages are of use primarily for experimenting to determine what kinds of insects carry virus diseases.

CONTROL OF FLEA-BEETLES ON POTATOES. G. W. Simpson. Experiments conducted to test the usefulness of arsenicals in the control of flea-beetles on potatoes in Aroostook County showed that there was a small increase in yield on the plots treated with arsenicals during the latter part of the season, but the increase in yield over plots carefully sprayed with Bordeaux was scarcely sufficient to warrant the use of arsenicals at the present level of potato prices. On the other hand, careful spraying with Bordeaux through the latter part of the season was decidedly beneficial from the standpoint of the growth of the plants.

Lead arsenate and calcium arsenate were tested, being added to the Bordeaux spray at the rate of 4 pounds to 100 gallons. The calcium arsenate was also tested at the rate of 6 pounds to 100

gallons of spray. Four applications of the arsenical spray were made to the plants in the test plots about the end of July and during August and early September. Poison was on the plants from the time of the first emergence of the second brood of flea-beetles until after the time of severe injury had passed. The spray was applied with a power-takeoff machine having three nozzles per row.

WIREWORM INJURY TO POTATOES. J. H. Hawkins. Wireworm injury to potatoes is of common occurrence and yet its importance is often overlooked. Sometimes as many as 30 per cent of the tubers grown in certain localities in Maine are severely injured by wireworms. The extent of such injury to the potatoes dug from experimental plots September 21 to September 30, 1934, is shown in the following table.

TABLE 8

The Number of Wireworms in the Soil in Relation to Injury to Potato Tubers

Number of wireworms per soil sample		Average per cent of injured tubers	Average number of punctures per 25 tubers
Spring	Digging time		
1-4	1-2	14	19
5-21	3-11	39	40
22-39	12-20	50	63
40-71	21-37	70	147
72-90	38-49	89	210
91-150	50-79	85	212
151-200	80-95	91	169
201-300	96-160	93	412

Each soil sample taken was $3\frac{1}{3}$ square yards in surface area. Digging was continued to such depth as wireworms were no longer found, most of them being present in the immediate vicinity of the potato hills. In a few instances wireworm injury was found where no wireworms were present at the time of digging. Such injury had been caused by wireworms that had changed to beetles, had died, or had dispersed to another place after injuring the tubers.

It may be seen from the table that there is a general increase in the percentage of tubers injured and in the number of punctures

per 25 tubers with a rise in wireworm population. An exception to this is found where 38 to 49 wireworms per plot caused a somewhat greater percentage of injury to tubers than did the larger population ranging from 50 to 79. However, in the latter case two more punctures for each 25 tubers occurred than where 38 to 40 wireworms per plot were involved.

It is necessary for each grower to consider his problem individually in estimating his chances of growing potatoes in wireworm infested soil. The data in the foregoing table, which are in general agreement with those of previous years, can be used with considerable confidence as a basis for predicting the approximate amount of injury caused to potatoes by wireworms. From this table the grower can form an estimate of the amount of injury likely to be caused to a potato crop where wireworms of various numbers inhabit the soil.

Whether or not wireworms are present in large numbers is important in deciding on fields to be used for potatoes. Poorly drained areas in medium or heavy clay soils are likely to be infested, especially if allowed to remain as grassland for a period of years. Many farmers know the exact location of wireworm infestations on their farms. Sometimes wireworms can be discovered by watching for them while plowing or fitting the land for crops. In order to estimate the chance of crop injury it is necessary to sift wireworms from the soil and count the number per unit area. For preliminary investigation, samples a square foot in surface may be taken at any time from early spring until fall. It is sometimes necessary to remove the soil to a depth of six or eight inches to secure all the wireworms present. The first samples can be taken in low areas where the presence of wireworms is suspected. If wireworms are found in these samples it would be advisable to take more and larger samples in order to locate the general infestation and establish the numbers present. The grower, by comparing the number of wireworms taken in his samples with data in the foregoing table, can estimate the amount of injury to be expected to potatoes planted in the fields from which he took his samples. In making comparisons the size of the samples taken should be considered, if the samples taken are not of the same size as those represented in the table, and the number of wireworms changed to correspond. That is, if a half-size sample is taken the

number should be doubled for comparison with the numbers in the table.

For a discussion of the control of wireworms see page 403.

DISTRIBUTION OF NEW SEEDLING VARIETIES OF POTATOES. Reiner Bonde. Several new varieties of potatoes have been developed through the coöperative work on degeneration diseases. The Experiment Station has increased the stocks of these new varieties and rendered them free from disease prior to their distribution for trial among farmers. The Katahdin variety was grown in an increase seed plot in 1933 and rogued free from all obvious virus diseases. This foundation seed stock was distributed among farmers and has been increased so that it is now being grown quite generally throughout the County.

The Chippewa is a more recently developed variety. This variety was grown in an increase plot in 1933 and the seed stock thus produced was distributed among ten growers. In 1934, approximately 100 barrels of disease-free seed stock was produced on Aroostook Farm and was distributed among farmers as foundation seed stock. The Chippewa potato is especially popular and the present demand both from Aroostook and buyers from other states greatly exceeds the supply.

The Katahdin variety appears to be well liked by some growers and a rather brisk out-of-state seed trade is being developed.

YIELD COMPARISONS BETWEEN GREEN MOUNTAIN, GIANT HILL, AND RUST PROOF. Reiner Bonde. The Rust Proof variety of potato is being grown by a large number of growers in spite of the fact that it is very late and often yields somewhat less than Green Mountains. Rust Proof is chosen because of its high resistance to "rust" and to tuber rot (both of the late-blight type) under field conditions very favorable for the development of this disease. It is also somewhat resistant to scab and is considered to be less damaged by storage bruises than is the Green Mountain and the other commercially grown varieties.

Tests made on Aroostook Farm have shown that the Rust Proof variety sets a large number of tubers which are apt to be undersized. This makes the yield of this variety somewhat less than that of the Green Mountain unless the growing season is long and the plants are given an abundance of space in the row and a heavy application of fertilizer. In 1934 the Rust Proof variety

was compared with healthy Green Mountains and with Giant Hill Green Mountains¹ under conditions affording more space in the row and with a heavier than normal fertilizer application.

In these tests the seed pieces were planted 15 inches apart in the row with approximately 2,500 pounds of 5-8-7 fertilizer applied per acre. The plot was also located on low-lying land where usually conditions are very favorable to late blight infection and to tuber rot. The plots received no spray applications throughout the season.

Although late blight was not generally abundant in 1934, it was conspicuous in the Green Mountain and Giant Hill plots while absent in the Rust Proof plots. It was noted also that a considerable amount of tuber rot developed in Green Mountain and Giant Hill. Tuber rot on the other hand was entirely absent in the plots of Rust Proof. This explains to some extent the fact that it yielded more than either Green Mountain or Giant Hill in these tests.

The yield comparisons for this test are summarized as follows:

Variety	Yield per acre		Odds
	Barrels	Bushels	
Rust Proof	175±1.99	479±5.33	Very high in favor of Rust Proof
Green Mountain	104±1.98	285±5.46	Ditto
Giant Hill	91±3.02	249±8.35	Ditto
			Odds in favor of Green Mountain in comparison with Giant Hill 65 to 1

The results show that the Rust Proof variety has considerable merit in years with a long growing season. The variety may be of value for small garden patches where it is not convenient to apply a fungicide for the control of blight. It also will do better than Green Mountains in locations that are characterized by excessive tuber rot and late blight infection. A few growers have reported satisfactory yields from this variety when good seed was planted.

¹ The nature of Giant Hill is not known. It may be found to be a disease, a sport, or an admixture and was included in these tests to determine whether resistance to rust is due to lateness of maturity.

It should be remembered, however, that the Rust Proof variety requires a long growing season, its seed pieces must be spaced far apart in the row, and the plants must be grown in good soil with an abundance of fertilizer. One serious objection to the Rust Proof variety is that virus-disease-free seed stock is relatively hard to obtain.

COMPARISON OF GREEN MOUNTAIN POTATO TUBER LINES. Donald Folsom. In order to develop Green Mountain seed stocks free of the recognizable virus diseases, such as mild mosaic, tuber lines have been originated as isolated tuber units and each line has been increased in isolated tuber-unit seed plots. In distributing such seed stocks among growers, a question often arises regarding the yielding ability and tuber type of such lines. In 1934 a replicated comparison of five such tuber lines was made on Aroostook Farm. The yield rates varied from about 187 barrels (516 bushels) an acre down to about 171 barrels (470 bushels). This is about the same percentage difference (about 9) as was obtained in 1933 between parts of the same tuber line grown on the same ground but coming from seed grown on different farms. The lowest yield in both 1933 and 1934 was from seed stock grown on Aroostook Farm the preceding year.

The percentage of 8-ounce tubers that were of good type varied from 58 to 66 per cent for the five lines. The percentage of good-type 8-ounce tubers varied similarly (from 59 to 67 per cent) for the five strains taken together in one part of the small experimental field *vs.* the same strains together in other parts of the field. The variation between lines was not significant while some of that between parts of the field was significant. The lowest percentage of good-type tubers came from the line grown on Aroostook Farm in 1933, which displayed the smallest plants on July 11 and the lowest yield rate.

It is concluded from these results that the several tuber lines involved probably are not inherently different from each other with respect to yielding ability or tuber type. If they are, at least such differences are harder to demonstrate than differences traceable to the varying environments of the present and previous seasons.

REDUCTION IN STAND OF POTATOES BY SEED PIECE ROT. Reiner Bonde. The losses in yield due to poor stands and poor

germination vary greatly from season to season. In 1932 a survey made in Aroostook County indicated that approximately 20 per cent of the seed pieces failed to germinate. In 1933 a similar survey was conducted in an attempt to estimate further the extent of these losses. An effort was also made to learn why farmers often had complained of poor seed piece germination. The results of this survey are summarized briefly in Table 9.

TABLE 9

*Summary of Survey to Determine the Percentage of
Stand in Green Mountain Potato Fields*

Percentage stand	Number fields in each class	Per cent of total number of fields in each class
95 or more	104	52
80 - 90	54	27
70 - 80	36	18
Less than 70	6	3

Average based on all the 200 fields examined, 87%.

A grower should normally have a 95 per cent stand provided conditions are favorable for the germination and emergence of the potato seed pieces. The survey showed that nearly 50 per cent of the growers failed to have good stands. It was found that *Rhizoctonia* infection was the greatest factor in producing unevenness of stands and that practically all fields were affected by this disease. In some cases the sprouts of 30 to 40 per cent of the hills were destroyed before they could emerge from the soil. Many hills were weak because of the sprouts being girdled by *Rhizoctonia*. At harvest time it was shown that *Rhizoctonia* also was very prevalent on the tubers (as black scurf).

The data show that growers should devote more effort to the control of *Rhizoctonia*. This is especially true in view of the fact that seed buyers are becoming more critical regarding *Rhizoctonia* infection on seed stock. In some fields poor stands were due to seed piece decay caused by *Fusaria* and by bacteria that cause soft rot.

Blackleg was very prevalent in 1934, especially in the Irish Cobbler variety. Twenty-seven fields of this variety were included in the survey. The average stand in this variety was 82 per cent which is somewhat less than for the Green Mountains. Of the 27 Cobbler fields, 62 per cent showed evidence of blackleg. This disease varied in amount from one to 15 per cent. The losses caused by it cannot be estimated entirely by the number of diseased plants present. When blackleg plants are present there is generally a prevalence of weak plants and of missing hills. Also, the cost of roguing the diseased plants and tubers in order to meet the certification requirements is an added expense. It is of interest, too, that most of the growers who experienced losses caused by blackleg had treated their seed stock prior to planting.

COOKING QUALITY OF POTATOES. Marion D. Sweetman. The relation of properties of starch to mealiness in potatoes is being studied in an effort to discover a means of controlling this quality. Cooking tests of Green Mountain potatoes grown on a series of plots receiving different fertilizer treatments showed a wide range of variation in mealiness for the 1934 crops as compared with that of tubers from similarly treated plots in the 1931 crop. In both years the most mealy tubers in the series were from the plot containing potassium in the form of potassium sulphate (K_2SO_4) while the least mealy tubers were from a plot fertilized with a mixture containing nitrogen and phosphorus but lacking potash. Although variations in mealiness are not uniform from year to year one may hope to be able to insure a high degree of this quality every year by appropriate soil treatment.

DAIRYING

AN ECONOMIC STUDY OF THE DAIRY INDUSTRY IN MAINE. George F. Dow. Considerable progress has been made in the analysis of data of the organization and management of Maine dairy farms. The information used in this study of dairy farms includes that for 178 complete dairy farm records that were secured throughout the State in 1928. These records represent dairying during a period when prices were relatively favorable for dairymen. In addition to this information, 255 complete dairy farm records were secured in the vicinities of Unity, Brooks, Bel-

fast, and Union in 1933. These records are for the year ending April 30, 1933 and represent dairy farms in an important wholesale milk and cream area during a period when prices were about the most unfavorable of any period during the recent depression. During the summer of 1934, a total of 291 dairy farm records were secured in the vicinities of Farmington and Portland. The Farmington area represents another important dairy section of the State which primarily supplies milk for the Boston market. The Portland area, on the other hand, represents a more intensive dairy section where milk is produced to be retailed in the nearby city of Portland.

The dairy records for 1928 and 1933 are being analyzed to determine those factors of farm organizations and management that affect dairymen's income. By including records for a year of high prices and for one of unfavorable prices, important comparisons may be made and conclusions drawn that will be of much value to the dairy interests of Maine. The additional dairy records that were secured this summer in Farmington and Portland will be used to study special problems that exist in these areas and to compare dairy farm organization and management in a wholesale milk area with that in a retail milk area where prices are higher and dairy production is more intensive.

During recent years considerable discussion has arisen concerning the effect of the depression on dairying and the need for a milk production control program. Consequently some comparisons have been made, based on the 1928 and 1933 dairy farm records and other information, to show how the depression has affected the income on Maine dairy farms, to determine what adjustments have been made in milk production, and to learn to what extent milk production has already been controlled in Maine and New England.

The Effect of the Depression on the Income from Maine Dairy Farms. A study of the cost and returns in producing milk indicates that dairymen's net returns have been much reduced. On farms where milk was sold, dairymen received for their labor in caring for cows only 8 cents per hour in 1933 as compared with 26 cents in 1928. On farms where cream was sold, dairymen in 1933 not only received nothing in payment for their labor but actually lost 2 cents for each hour spent in caring for cows, as compared with an income of 23 cents in 1928. In other words, on milk farms,

dairymen put in an average of 197 ten-hour days per herd during the year in caring for cows and for their labor received only \$153 to be used to meet personal expenses such as food, clothing, and education. On the farms selling cream, dairymen utilized an equivalent of 174 ten-hour days per herd during the year in caring for cows for which they received no net income but lost \$43 in addition to their labor.

TABLE 10

Comparison Between 1928 and 1933 in the Receipts, Expenses, and Income on Maine Dairy Farms

Item	Value per farm		Percentage decrease
	1927-28	1932-33	
Receipts:			
Increase in capital	\$ 174	\$ 5	97.1
Crops sold	935	265	71.7
Livestock sold	632	139	78.0
Dairy products sold	1,217	458	62.4
Miscellaneous	630	235	62.6
Total receipts	3,588	1,102	69.3
Expenses:			
Livestock purchased	174	32	81.6
Farm expenses	2,587	1,044	59.6
Total expenses	2,761	1,075	61.1
Farm income	827	27	96.7
Interest on capital (5%)	551	261	52.6
Labor income	+ 276	- 234	

The returns in raising heifers on Maine dairy farms also showed a considerable decrease from 1928 to 1933. This decrease was due primarily to a lowering of the value per heifer at time of freshening from \$81 in 1928 to \$38 in 1933.

A study of receipts, expenses, and income for comparable Maine dairy farms also shows considerable change from 1928 to 1933 (Table 10). During the depression, in 1933, dairy farmers received for their year's work on the farm, in addition to a house in which to live and farm products used in the household, a farm income of \$27 as compared with \$827 per farm in 1928. After

charging interest at 5 per cent on the capital invested in dairy farms, dairymen's labor income in 1933 showed a loss of \$234 as compared with a profit of \$276 in 1928.

A study of the individual items, in Table 10, that comprise receipts and expenses gives an indication of how dairymen adjusted their farm businesses to declining prices. In the first place, dairymen were doing as little work as possible in repairing and improving their buildings and equipment. As a result, the value of improvements, as indicated by the net increase in capital, showed a 97 per cent reduction during the depression. The income from crops, livestock, and dairy products sold showed a decrease ranging from 62 to 78 per cent below the income for 1928. The total of all receipts in 1933 was 69 per cent less than in 1928. Farm expenses, however, did not show as much of a decrease, dropping only 61 per cent. As a result, 51 per cent of the dairymen in 1933 had a minus farm income, before any deductions were made for interest on the capital, as compared with only 16 per cent with a minus farm income in 1928.

Factors Responsible for Decreased Income. As shown in Table 10, both expenses and receipts in the operation of farms show a decline during the period of depression. If the retail price of things that farmers buy had decreased on the average as much as the wholesale price of things that farmers sold, a decreasing price level would not have had an injurious effect on dairymen. However, there is always a tendency during a general price decline for the wholesale price of farm commodities to decrease more rapidly than the price of things that farmers buy. For example, the price of grain paid by dairymen decreased 47 per cent, the price of hay 21 per cent, and the cost of farm labor 41 per cent, while the value received by dairymen for milk decreased 50 per cent, the value of cows 53 per cent, and the value of sweet corn 53 per cent.

In addition to the unfavorable relationship between prices during a depression, the dairy industry has also been handicapped by two other factors, an increase in the number of cows and a decrease in milk and cream consumption. The number of cows reached a low point for the United States in 1928 and for New England in 1929 with a resulting high price for dairy cows and dairy products. As is customary, these high prices stimulated and

caused an increase in the number of cows. On January 1, 1934, the number of cows was 7.7 per cent higher in New England and 17.8 per cent higher for the United States as a whole than during the period when the present cycle of cow numbers was at its lowest point. As a result of increased numbers of cows dairy prices have been forced to considerably lower levels than would have occurred as a result of the depression alone.

Milk and cream consumption as indicated by shipments to Boston and Metropolitan area were not affected by the depression until 1931. During 1932 and 1933, however, milk and cream consumption decreased and in 1933 was approximately 10 per cent below that in 1931.² This decrease in demand has had an unfavorable influence on the income of dairy farmers.

Adjustments Made by Maine Dairymen. As a result of unfavorable conditions, dairymen in Maine and the other New England States have made considerable adjustments in dairy farm organization and management. An indication of these adjustments is found in the decrease in the pounds of grain fed per cow annually. The records in the 1933 survey show an average of only 1,130 pounds of grain fed per cow as compared with 1,778 pounds in 1928 or, in other words, a 36 per cent decrease during the five-year period in the amount of grain fed. Apparently, as a result of this radical change in the feeding of dairy cows in Maine, milk production per cow decreased approximately 12 per cent.

Dairymen's adjustments during the depression resulted primarily in a decrease in cash expenses with the hope that losses might be diminished. In other words, dairymen in 1933 were feeding less grain, which was largely a cash expense, and were feeding more hay and other home-grown roughages. These adjustments may have resulted in a decrease in cash losses but have not resulted in increased efficiency in milk production. In fact, the opposite is true. By decreasing the amount of grain fed per hundredweight of milk and consequently increasing the amount of hay, hours of man labor, etc., required per hundredweight of milk, the resulting net cost of milk production showed an increase during the depression. To prove this point, a formula to be used in computing the

² Receipts of Milk and Cream at Boston and Metropolitan Area by States. Market News Service, Bur. Agr. Econ., U. S. Dept. Agr. Mimeographed summaries by months.

cost of producing milk was determined from the 1928 records. This formula showed the pounds of milk, pounds of hay, pounds of silage, hours of man labor, etc., required to produce 100 pounds of milk containing 4 per cent of butterfat under 1928 conditions. A similar formula was also computed from the 1933 records showing the ingredients necessary for milk production under 1933 conditions. If, in 1933, dairymen had continued to feed and care for their cows the same as they did in 1928, the computed net cost of producing milk based on prices that existed in 1933 would have been 22 cents less per hundredweight than the actual cost of production based on the 1933 formula. Also if we used the price of grain, hay, silage, and man labor for November, 1934, the cost of production was 28 cents more per hundredweight based on the 1933 formula than if dairymen had continued to feed and care for their herds as they did in 1928. In other words, if one considers the farm value of hay, silage, and man labor as though each were a cash cost based on what farmers would have to pay for these items, these adjustments that have been made during the depression are not economical from the sole standpoint of the efficiency of milk production. Nevertheless, because these dairymen hired only 18 per cent of the labor required per farm and purchased only a small proportion of the roughage fed, they found it desirable to cut down on cash costs. By this means dairymen reduced cash losses but received only a very limited return for their own labor and roughages raised. Such adjustments may be advantageous as an emergency measure but due to decreased efficiency in milk production should not be followed as a long-time program.

Extent to Which Maine and Other New England Dairymen Have Controlled Milk Production. In view of the discussion by the Agricultural Adjustment Administration of the eventual need of a milk production control program in the United States, it is desirable to learn to what extent New England dairymen have already controlled production on their own initiative. Good evidence of such production control has already been indicated in this report by the statement that the number of cows in New England have increased only 7.7 per cent from the low point in 1929 to January 1, 1934, whereas the increase from the low point for the United States as a whole was 17.8 per cent. The sale of milk, cream, and other dairy products, however, is a much more impor-

tant measure of milk production control, as it has been proposed that control plans be based on actual sales rather than on estimated total milk production or number of cows.

The best available gauge of the extent to which New England dairymen have controlled sales is furnished by the trend in cream shipments from New England to Metropolitan Boston. These shipments of cream are an accurate measure of dairy sales because New England first supplies the total demand for fluid milk within its own boundaries, and then utilizes its surplus milk primarily in the form of cream. The balance of the cream supply comes from New York and states farther west such as Wisconsin, Michigan, and Missouri. The proportion of the total cream supply that is produced outside of New England, therefore, indicates the extent to which New England dairymen have controlled their sales of milk and cream. Accurate figures, which have been available only since 1930, show that states outside of New England supplied only 22 per cent of the total cream received at Boston in 1930 but that this proportion has increased each succeeding year to 38 per cent in 1931, 42 per cent in 1932, and 44 per cent in 1933 (Table 11). In other words, New England dairymen have controlled their sales of milk and cream during the depression, in spite of an increase in cow numbers, and have surrendered an increasingly greater proportion of their cream market to the mid-west.

TABLE 11

Total Cream Receipts at Boston and Metropolitan Area, 1930-1933¹
(In 40-Quart Cans)

Year	Total from all States	From New England	From outside of New England	Per cent received from outside New England
1930	582,446	455,523	126,923	21.8
1931	588,110	364,987	223,123	37.9
1932	542,005	315,805	226,200	41.7
1933	539,406	302,819	236,587	43.9

¹ Receipts of Milk and Cream at Boston and Metropolitan Area by States. Market News Service, Bur. Agr. Econ., U. S. Dept. Agr. Mimeographed summaries by months.

Another indication of milk production control in New England is found in the figures of the utilization of milk delivered to

dealers buying through the New England Milk Producers' Association. In 1928, an average of 44.6 per cent of this total milk supply was sold as surplus milk, whereas in 1933 only 31.4 per cent was sold as surplus. In spite of an increase in the number of cows and a decrease in milk consumption, these dairymen limited their milk production so that a smaller proportion of the total milk delivered needed to be converted into cream or manufactured dairy products.

Maine, similar to all New England, has not been responsible for any of the recent increases in the total of milk and milk products sold in the United States. In 1933, Maine supplied only 11.7 per cent of the total milk and cream received at Boston and Metropolitan area as compared with 12.4 per cent of the total in 1930.³ Although creamery butter and cheese are not important in Maine, production of these products has also been decreased. In 1933, the amount of creamery butter manufactured in Maine was only 39,000 pounds as compared with 348,000 pounds in 1928.⁴ Similarly, production of American cheese was only 60,000 pounds in 1933 as compared with 88,000 pounds in 1928.⁴ Ice cream production during the same period decreased from 1,504,000 gallons to 864,000 gallons.⁴

ANIMAL BREEDING AND NUTRITION

NUTRITIONAL DEFICIENCY DISEASES. W. Franklin Dove. The problem of correcting nutritional deficiency diseases in both livestock and human beings of the State through the production of superior foods has been the subject of study for a number of years past and is still under experimental analysis. Information on climatic factors, on soil fertility, and on defects occurring in livestock and in humans has been brought together in order to discover some of the underlying causes of and remedies for the existing conditions. On the constructive side of the problem an extensive series of nutrition experiments has been completed. The results of these experiments indicate the presence of a supply of

³ Same as Footnote 2.

⁴ Dairy Products Manufactured by States. Bur. Agr. Econ., U. S. Dept. Agr. Annual summaries.

vitamins and minerals in Maine sea foods. To date sea-food products and by-products of the Maine coast appear to provide the most readily available source of supply for these accessory food factors. Biological assay of these sea-food products has disclosed a nutritive value heretofore unrecognized. The Maine vacuum-dried White fish has been shown to contain vitamin D and also vitamin G; the herring, vitamin D and possibly some vitamin G.

The results of the studies that have been made on this problem to date have been brought together in Bulletin 375. Many phases of the problem are still being studied through the accumulation of additional information by means of health surveys and crop analyses, together with new experiments on the formulation of superior rations.

The ultimate purpose of these experiments is to discover the most efficient means of endowing certain foods—milk, meat, butter, and eggs—with factors essential to human health. Foods that are superior with respect to vitamins and minerals, are the products of healthy animals wisely fed. Since the same factors required for the production of superior foods for human beings also improve the efficiency of production and the health of the producing animal, the profit motive alone should be a sufficiently constant goal. But the profit motive alone will not supply the guide to the discovery of more efficient rations; some other guide should be maintained through continued experimentation for the detection of superior rations adapted to the excessive demands of healthy, high-producing strains of animals.

THE FORMULATION OF SUPERIOR RATIONS FOR HIGH-PRODUCING ANIMALS. W. Franklin Dove. During the past twenty-five years the geneticist has been able to materially increase the producing ability of many domestic animals by especially devised methods of selection. Since this increased individual production, properly utilized, results directly in economy of production, the procedure is justified. But increased production makes heavier demands upon the ration, and, unless the rations fed to these superior strains of domestic animals contain the required nutritive factors, then selection of high-producing strains of animals loses a large share of its value. In other words, the genetic selection for

superior strains of animals should be paralleled with the formulation of superior rations.

This direct association between breeding and feeding may appear obvious, and yet the returns from a questionnaire survey of the dairy breeders of the State reveal that many breeders of pure-bred livestock do not consider feeding and breeding as of equal importance. Many breeders of pure-bred livestock feed rations on which only scrub animals could survive. Some breeders are aware of this fact since 15 per cent indicated a dissatisfaction with the rations they are feeding. Furthermore, the prevalence of nutritional deficiency diseases and the gradual increase in mortality rates suggest a failure to combine the driving force of genes for high production and the proper nutrition.

THE UROPYGIAL GLAND OF BIRDS AND VITAMIN D ASSIMILATION. W. Franklin Dove. The uropygial gland, the small gland near the tail of birds, has been considered by comparative anatomists as the only skin gland of the domestic fowl and homologous to the oil (sebaceous) gland of mammals. During the past ten years evidence has been brought forth by a number of students of nutrition and biochemistry which indicates that the oil secretions of the skin of mammals are the source of the parent substance of vitamin D, and that the ultra-violet rays of sunlight change the ergosterol complex into a biologically active product valuable as a preventive of rickets. If these assumptions are true then the chicks lacking this gland would be prevented from securing the beneficial effects of sunlight. Some strains of birds are known to lack these uropygial glands.

In 1928 and in 1929, tests of this hypothesis were made by surgically removing the uropygial glands from newly-hatched chicks and subjecting them to the biologically active ultra-violet rays of the mercury arc lamp as the only means of securing vitamin D. The results were contrary to expectations: chicks without the gland grew nearly as well as chicks with the gland. The differences were not statistically significant.

Since then, the Chinese experimenter Hou has reported that removal of the uropygial gland of birds prevented them from assimilating ultra-violet rays—that removal of the gland resulted in the development of a rachitic condition in birds.

In the meantime experiments on this subject have been continued in this laboratory, by Miss Elizabeth Murphy,⁵ on large numbers of chicks held under controlled laboratory conditions with a standardized ricket producing ration in an artificially-lighted laboratory with no sunlight. Under these standardized conditions chicks with glands removed were unable to grow normally and finally succumbed to rickets as shown by the low ash content of the bones. On the other hand, when chicks (taken from the same hatch) with glands removed were treated with the ultra-violet rays from a mercury arc lamp they grew rapidly, remained healthy, and developed strong bones high in ash content equally well with those chicks receiving cod-liver oil in their rations. Chicks with the glands removed and at the same time with access to ultra-violet ray treatment do not always equal the growth rate of normal unoperated chicks under identical conditions except for this gland. Out of five separate tests, two groups of chicks lacking the glands and receiving ultra-violet ray treatment failed to equal the growth of the unoperated, normal chicks. The differences in growth were, however, barely three times the probable error of the difference in growth, and, since the unoperated chicks were inferior in growth rate to the chicks lacking glands in the other three experiments these differences are probably not significant.

From these experiments it appears that the uropygial gland is certainly not the only source of secretions that are essential for the assimilation of ultra-violet rays and the prevention of rickets.

DETERMINING THE TIME OF EMBRYONIC MORTALITY, FROM THE POSITION OF THE EMBRYO (DOMESTIC FOWL). W. Franklin Dove. The problem of mortality is increasing in importance. Studies on the causes of embryonic mortality have been carried on in this laboratory since 1927. In connection with the project, all chicks failing to hatch have been given a post-mortem examination for evidences as to the cause of death. Teratological defects have been recorded and classified for different strains of birds fed different rations, in order to detect the association, if any should exist,

⁵ Murphy, Elizabeth F. 1934. An Experimental Study of the Relation Between the Uropygial Gland and Vitamin D Deficiency in Birds. A Thesis (in Physiology), School of Graduate Study, University of Maine, Orono, Maine. Library No. 612.39/M953, June, 1934. 45 pp.

between hereditary factors or nutritional factors, and embryonic mortality. This work is still in progress.

As a subsidiary phase of the post-mortem examinations, the position of the chick within the egg has been recorded. Since Sanctuary's report in 1925 of an association between position of embryo and death, a number of workers have extended the analysis so that at the present time six different positions of embryos are recognized as possible "causes" of death.

The writer, however, has considered the problem from another point of view, i.e., that malposition is only rarely a *cause* of death and is due rather to the after-effect of more deeply-seated organic defects which result in a distortion of the body. Furthermore, the positions taken indicate the age at which position change ceased. This conclusion is based not alone upon the classification of defects found in dead embryos but upon observations made on a large number of healthy, normally developing chick embryos examined at various stages during the incubation period.

The analysis of the records shows that the embryos change position in a generally uniform manner from day to day.

From a combination of the records on live chick embryos with the results of observations on thousands of embryos whose distorted positions have been caused by nutritional or hereditary factors (chondrodystrophy, anemia, goitre, etc.), a code for position of embryos has been constructed. A graphic representation of these positions (normal and abnormal) taken by chick embryos is shown in Figure 44.

This codification of position has been in use in this laboratory for a number of years and has proved of great assistance in determining, in doubtful cases, the age of death of embryos. Furthermore, the code includes not only the six positions so far discussed by other workers plus an additional eleven not as yet reported in the literature, but also brings all position changes into a simple, logical schema for further analysis of this interesting phase of embryonic mortality.

Figure 44 has certain very practical applications since it may be used to determine more accurately the stage of incubation when factors enter to interfere with normal development. Many embryos live to the last day of incubation (21 days), and yet fail to hatch on that day. Failure to emerge might be interpreted as a

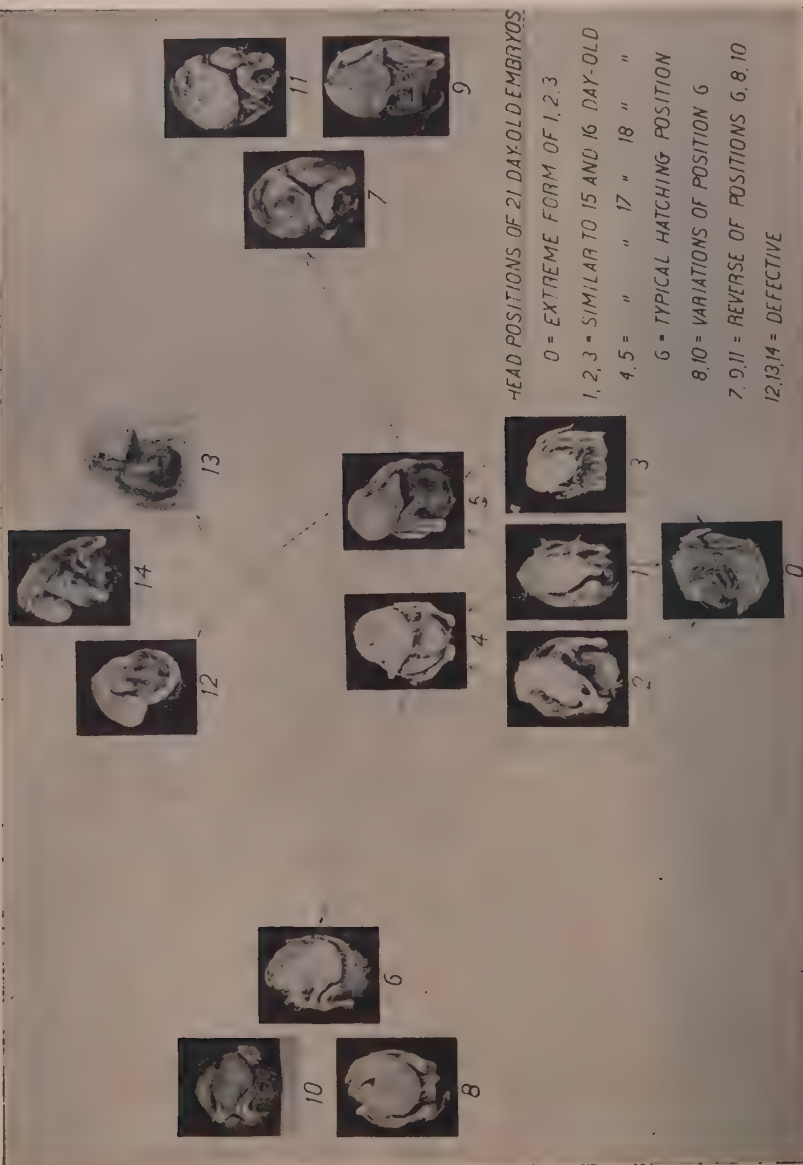


FIG. 44. A graphic representation of the natural positions taken by chick embryos. All embryos had lived the full length of the incubation period—21 days—and yet some (0-5) were retarded in position and were similar to embryos one to six days younger. Others (12-14) show the effects of severe organic defects upon position. The most frequent normal chick position is shown in number 6, with 8 and 10 as variations from the mode. The mirror images of the modal position types are shown by numbers 7-11. Numbers 1-2-3 represent three variants of the position taken by 15 to 16 day-old embryos. The arrows indicate the series of changes in position with each succeeding stage. Positions 4 and 5 are representatives of 17 and 18 day-old embryos—with position 4 as the representative of the stage preceding the group of "head-to-the right," and with its partner, number 5, as the representative of those to move "head-to-the left." Numbers 12 to 14 represent defective types, some of which may gain their position through the series—as indicated by arrows—as variants of the 17-18 day-old embryo (position 4 and 5). On the other hand these distorted positions are noted many times in embryos only 9-11 days old. Position 0 is an extreme of the normal position of the 15-16 day-old embryo. This embryo failed to raise the head after the 16th day of incubation, and, with continued growth in size of body, the head was forced lower between the legs. Positions 0, 1, 2, 3, 4, and 5 represent retarded position types, and, together with positions 12, 13, and 14 represent the effect of faulty development.

The failure of these retarded chicks to hatch on the 21st day of incubation is, therefore, not due to malposition, but, rather, the position indicates the existence of a more deeply-seated defect in development which has started action many days prior to the date of death and has resulted in the failure to shift position in the normal manner as age advances.

failure in the incubation process or in the equipment on the 21st day, but from the position of the embryo, one may determine more exactly the date when the lethal factor first made itself apparent, and from such information be able to discover the real cause of the failure to hatch.

APPLES

BREEDING NEW VARIETIES OF APPLES. Russell M. Bailey and Iva M. Burgess. There is a great need in Maine for a winter apple variety having the quality, attractiveness and adaptation of the McIntosh. An orchard comprised of hybrid seedlings has been started and new trees are added as facilities permit. This need for a better winter variety was greatly emphasized by the severe injury occurring last winter in most of the late varieties grown in the State. Additional crosses of McIntosh have been made with such varieties as Spy, Red Delicious, and Golden Delicious to provide seedling populations for selecting suitable varieties.



FIG. 45. Seedling apple trees are grown at Highmoor Farm to aid in the production of new varieties.

APPLE POLLINATION STUDIES. Russell M. Bailey and Iva M. Burgess. This work was somewhat handicapped by the severe injury which occurred last winter. However, data have been accumulated over a period of several years and with a few exceptions are in close agreement. Attention has been confined chiefly to a study of McIntosh, Red Delicious, Spy, Wealthy, Golden Delicious, Cortland, Baldwin, Greening and Gravenstein which are the most important varieties in Maine. When the first six varieties listed were used in hand pollinations, good sets of fruit have generally resulted. These varieties have a normal diploid complement of chromosomes and in consequence produce potent pollen. On the other hand, Baldwin, Greening and Gravenstein pollen has consistently been ineffective in inducing a satisfactory set of fruit. This is probably associated with the triploid, or at least irregular, chromosome condition in these varieties. Self pollination of any of the varieties studied has resulted in a very small set of fruit or in none at all, more often the latter.

APPLE TREE SHAPE IN RELATION TO YIELD AND GROWTH. Russell M. Bailey and Iva M. Burgess. In this experiment the scaffold branches of alternate Golden Delicious trees of one row are tethered in a horizontal position each summer to produce an open type of tree. The other trees in the row were left to serve as checks. This year the mean yield of the treated trees was 37.9 pounds and that of the checks 21.0 pounds. Odds that the difference is significant are 30:1 obtained by "Student's" method of paired observations. The "tied down" trees yielded significantly more in 1932 but not in 1933. Trunk diameter measurements this year showed the checks to be slightly larger than the treated trees but the difference was not significant. Prunings, consisting chiefly of "water sprout" growth, were weighed and 1.5 pounds were removed on the average from the treated trees and 1.1 pounds from the checks. Odds that the differences were significant are very great. It would seem that opening the tree by tying down the branches has increased sucker growth and has during two years out of three increased the yield slightly.

APPLE FRUIT FLY OR RAILROAD WORM. *Control.* Frank H. Lathrop. Observations made during the past summer indicate that neglected trees in the neighborhood continue to be a difficult problem to the commercial orchardist. The removal of many winter-

injured trees has decreased the number of neglected trees to some extent. A large part of the winter injury occurred on Baldwins and other late varieties which usually do not produce excessive numbers of flies. Varieties such as Red Astrachan and the early sweet apples which produce a large proportion of the fly population, suffered relatively little winter injury and in many communities such trees continue to provide a dangerous source of fruit fly infestation.

The experience of Maine fruit growers during the past summer generally indicated that under favorable conditions two well-timed applications of calcium arsenate spray successfully combated the fruit fly in commercial apple orchards. Failures to control the infestation in well sprayed orchards were usually attributable to late season drift of flies from neglected trees.

Life History Studies. Charles O. Dirks. Certain detailed studies of the life history of the fruit fly were brought to a conclusion during the past season, and it is now possible to summarize the work of the past three years.

Records are available showing the relative numbers of larvae

TABLE 12

Numbers of Fruit Fly Larvae Developed from Three Varieties of Apples

Variety	Year	Number of apples used	Number of larvae developed	Number of larvae per 1,000 apples
Red Astrachan	1931	1,950	6,957	3,567
" "	1932	3,400	11,789	3,467
" "	1933	5,872	13,410	2,312
Totals and average		11,222	32,156	3,115
Wealthy	1931	5,430	26,836	4,879
" "	1932	3,059	6,540	2,138
" "	1933	5,900	24,117	4,087
Totals and average		14,389	57,493	3,701
Baldwin	1931	¹ 1,075	124	111
" "	1932	1,000	246	246
" "	1933	3,800	548	144
Totals and average		5,875	918	167

¹ Most of the Baldwin apples were stolen on October 18, 1931.

that may develop from apples of an early variety, Red Astrachan; a fall variety, Wealthy; and a late variety, Baldwin. The periods during which the larvae leave the fruits of the respective varieties have also been determined.

The difference in the number of larvae that develop in summer and fall apples as compared with the number from late varieties such as Baldwin is significant. The fact that an average of as many as 3 or 4 larvae per apple may develop from susceptible varieties strongly emphasizes the necessity for frequent and careful removal of drops from under such trees. The importance of neglected trees near the commercial orchard as a source of fruit-fly infestation is also clearly indicated.

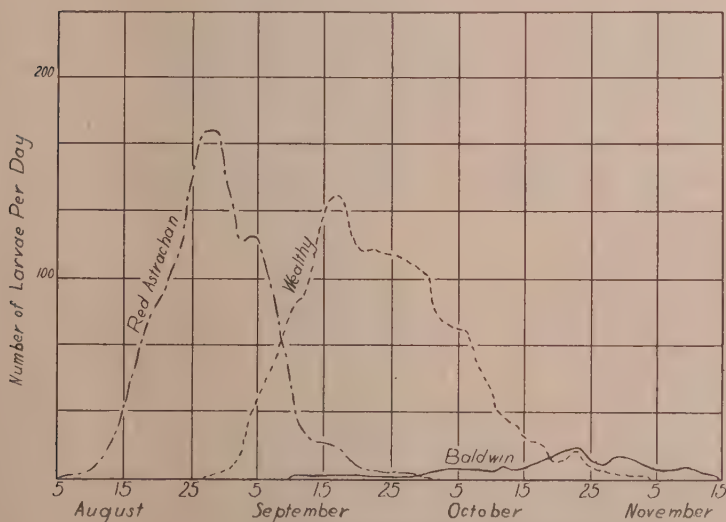


FIG. 46. Chart showing the periods during which fruit fly larvae leave the apples to enter hibernation quarters in the soil. The curves illustrate strikingly the large numbers of larvae that develop in early apple varieties such as Red Astrachan and Wealthy as compared with late varieties such as Baldwin.

The period during which the fruit fly larvae leave the apples varies according to the variety (Fig. 46). In general the larvae

emerge first from the early varieties. Somewhat later emergence begins from the winter apples. Larvae usually begin leaving Red Astrachans about August 5 and about three weeks later the first larvae appear from Wealthy. Approximately the same time interval occurs between the peaks of emergence of larvae from the two varieties. Larvae continue to leave the Wealthy fruits in considerable numbers for a period of six or seven weeks after the height of emergence for the variety. A small number of larvae leave the Baldwin fruits over a long period, beginning early in September and continuing until cold weather stops all insect development, usually about mid-November.

The rapid emergence of large numbers of larvae from early apples indicates the necessity for the frequent removal of drops from under such trees. In practice it has been found that drops should be removed from under early apple trees twice a week. Because of the comparatively slow development of larvae in the winter apples, removal of drops from such varieties once every seven to ten days is usually satisfactory.

Emergence of Adult Flies. Charles O. Dirks. As the timing of the spray applications for the control of fruit fly is determined

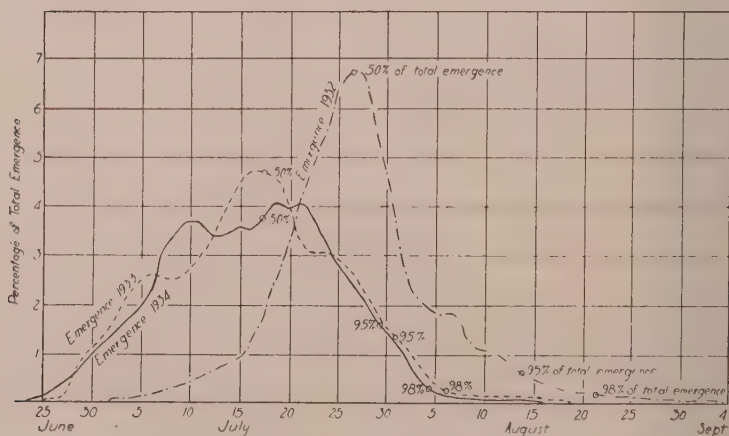


FIG. 47. Chart showing the emergence of apple fruit flies from the soil at Highmoor Farm during the years 1932, 1933, and 1934. The emergence during 1932 occurred later than usual, which made satisfactory control by means of spray applications unusually difficult.

by the dates of emergence of the flies, careful studies of this phase of the life history of the insect have been continued in the principal apple growing sections of the State.

During the summer of 1934, the first flies appeared about the end of June (Fig. 47). The period of greatest emergence occurred between July 15 and 20, and practically all of the flies had emerged by August 15. During this period of approximately 40 days, at least 98 per cent of the flies emerged from the soil. These dates apply to conditions at Highmoor Farm, Monmouth. In other orchard areas of the State the emergence of flies may occur a few days earlier or later, depending upon local conditions.

The records show that during the past summer the fruit flies emerged from the soil at about the usual time. The life of these insects appeared to be shortened, however, probably by the unusually warm, dry weather during July and August, and the flies disappeared from the trees somewhat earlier than usual. Eggs were deposited in sufficient numbers, however, to produce severe infestation of the fruit in many localities.

During the course of the work, the emergence of flies was studied over a wide range of conditions varying as to shade, soil, and apple varieties. Soil temperatures appear to have influenced the time of fly emergence to a greater degree than the time of maturity of the fruit in which the larvae developed. Flies emerged from areas exposed to sunshine 10 to 13 days earlier than from shaded areas. No consistent differences in time of fly emergence were observed, in the studies at Highmoor Farm, whether the larvae developed from summer, fall, or winter fruits.

Of the flies that emerge early in the season, about two-thirds are females; toward the end of the season the proportions are reversed and about two-thirds of the flies are males. This makes it evident that the early flies are of great concern, but the late flies that emerge in small numbers toward the end of the season are of little or no practical importance. The males and females emerge in about equal proportions during the peak of the emergence period.

It has been found that of the larvae that enter the soil during any summer, a large proportion transform into flies the following summer. A small proportion remain dormant in the soil, to transform into flies during the second or third summer. Observations

on the history of 55,874 larvae show that 30 to 40 per cent emerge as flies during the first summer after they hatch; about 2 per cent emerge as flies during the second summer; and about one-tenth of one per cent emerge during the third summer. Approximately 55 to 70 per cent of the larvae under observation died in the soil without completing their transformations. The ability of the insect to lie dormant in the soil until the second summer, and then transform into flies, is important in the life economy of the insect, and the habit increases the difficulty of combating the pest. The proportion of larvae that lie dormant until the third summer is so small that it probably is not an important factor.

ELECTRIC LIGHT TRAPS FOR COMBATING APPLE INSECTS. Frank H. Lathrop and Charles O. Dirks. During the past summer an experiment was undertaken⁶ to determine the value of electric light traps for the control of insects attacking apples. Fourteen traps were placed in a block of Tolman Sweet apples at Highmoor Farm. Each trap consists of a 75 W. Mazda electric light, surrounded by a cylindrical cage of electrically charged wires. The insects attracted by the lights are killed when they come in contact with the charged wires. The experiment was arranged so that in the future, after sufficient data have accumulated, comparisons may be made of the efficiency of one trap to two, three, four, and six trees, respectively.

The traps were installed in time for the experiment to begin on June 18. Obviously the results of the season's work are incomplete, as much injury to the fruit may have occurred before the experiment was initiated.

During the fore-part of the season the regular schedule of arsenical sprays was applied to the entire orchard block. After the experiment began no arsenic was applied to the trees in the light trap plot.

Examinations of the fruit at the time of harvest showed that 11.4 per cent of the apples from the trap plot were injured by insects, and 4.1 per cent of the apples from the sprayed trees were injured. As would be expected, there was a considerable increase in the percentage of fruit injured by fruit fly where the arsenic was omitted from the late cover sprays. Judging from the behavior

⁶ The Central Maine Power Company coöperated in the study to the extent of installing the equipment and the cost of electricity used.

of the apple fruit fly, there is little reason to suppose that this insect would be combated effectively by means of light traps. Omitting the fruit fly injuries from consideration, it was found that 2.5 per cent of the fruits from the trap-light plot were injured by other insects, against 1.8 per cent from the sprayed area. The increase in percentage of fruits injured by insects other than fruit fly on the trees from which the late season arsenical sprays were omitted is hardly as great as would be expected had no light traps been operated. Hence, it appears that the light traps were of some value in reducing injury to the fruit. Just how great an influence the light traps may exert cannot be determined from the preliminary data available.

Regardless of the efficiency that may be attained by the use of light traps for combating certain insect pests, it will, nevertheless, be necessary to apply a regular schedule of sprays for the control of fungous diseases and fruit fly in most apple orchards in Maine. It, therefore, seems that electric light traps should be regarded primarily as a possible adjunct to the spray schedule and not as a substitute for spray applications.

APPLE SCAB CONTROL. Donald Folsom. Apple scab control was studied in two varieties of apple on Highmoor Farm. Special attention was given to russetting on Golden Delicious fruits.

Small McIntosh Trees. Of 368 McIntosh trees mostly receiving the same spray or dust treatment for the seventh consecutive year, 205 (56 per cent) produced blossoms. In comparing the several treatment series, the number of blossom clusters was found to

Treatment	Lead arsenate	Sulphur dust	Sulphur dry mix	Untreated	Lime sulphur
Total trees	68	65	69	75	69
Average stem circumference (cm.)	15.5	15.8	16.0	15.1	15.2
% blossoming	66	68	65	55	33
Average no. blossom clusters	30.3	29.5	25.7	15.8	8.2

be significantly lower (with odds of over 1,000 to 1) in the lime-sulphur series than in the lead-arsenate, sulphur-dust, and sulphur dry-mix series; and also lower in the untreated series as compared

with the lead-arsenate. Apparently blossom bud formation was retarded by lime sulphur most, by leaf scab somewhat, and by lead-arsenate burning not at all. Stem size at the time of blossoming was not correlated much, if any, with the number of blossoms per tree. In pairs of trees 20 feet apart, receiving the same treatment and having the same trunk circumference, there were such differences as 0 *vs.* 166, 27 *vs.* 211, and 30 *vs.* 125 flower clusters.



FIG. 48. Demonstrating the eight-nozzle spray rod or gun as used on Highmoor Farm. The saving in labor and material is greater with larger trees. The results are at least as good as with the standard single-nozzle gun.

Fruits were found on 39 per cent of the trees. The number of ripe fruits usually equalled or exceeded the number seen on July 19 when they were green, indicating that only little if any dropping had occurred during the latter part of the summer. The number of young fruits per tree on July 19 was lowest in the lime-sulphur series which also had the lowest percentage of blossoming trees to bear fruits. The lead-arsenate series had the most fruits per tree and next to the highest percentage of blossoming trees to fruit,

though as usual having the most leaves burned and having about as much leaf scab as the untreated checks. The yield of ripe fruits by weight also was lowest in the lime-sulphur series and highest in the lead-arsenate series.

During this season a wettable flotation sulphur was used on the "sulphur-dry-mix" series, and dry lime sulphur spray was used at the prepink application on this series and on the dust series. On July 19 no scab was found on about 2,000 leaves from about 20 trees in each of the series receiving respectively lime sulphur, sulphur dust, and sulphur spray. Scab was found on less than 4 per cent of the leaves examined similarly in the lead-arsenate and untreated series. Scab was absent from the 987 fruits from the former three series and present on about 25 per cent of the 907 fruits from the latter two series. With so little scab present it is interesting to note that the untreated trees ranked somewhat better than usual in trunk enlargement and that the lead-arsenate series, though burned the most, yielded most and grew the most. None of the differences in the accompanying data on burning, yield, and stem growth and size

Treatment	% leaves burned	Lbs. fruit per tree	Stem circumference (cm.)	
			Increase	Final
Lead arsenate	24	2.0	3.46	18.93
Dry lime sulphur spray	17	0.5	3.16	18.39
Sulphur spray	13	1.4	3.26	19.30
Sulphur dust	11	0.9	3.17	18.97
Nothing (checks)	8	0.6	3.28	18.36

are significant except yield of the lead-arsenate series *vs.* all other series, and yield of the sulphur spray series *vs.* the dry lime-sulphur.

Golden Delicious Trees. In 1934 several variations in the method of applying dry-lime sulphur and lead arsenate were tested on rather young bearing Golden Delicious trees. Marginal and tip necrotic burning of the leaves, scab of leaves and fruits, and russetting of fruits were determined, with averages given in the accompanying data. The lowest and highest leaf-burn percentages were significantly different from the others. Scab was not severe even on the untreated trees and was easily controlled.

Treatment	% leaves burned	% leaves scabby	% fruits scabby	% fruits russeted	Total fruits
Check. Lead arsenate at prepink	18	2	29	49	7,618
Single-nozzle gun at six applications	54	0	0	37	1,272
Eight-nozzle rod at six applications	43	0	.04	59	2,781
Rod at first three applications	73	0	.6	32	2,727
Rod at last three applications	42	0	.1	75	2,112

Of the 16,510 fruits examined, over 50 per cent were russeted on a fifth of the surface. About as much russeting as this was found on the untreated check fruits (see accompanying data) and the condition can hardly be correlated with kind of spray treatment or location. The crops from 54 individual trees were examined separately. Their russet percentages varied from 6 to 96, differing in two adjacent pairs of unsprayed trees by 20 *vs.* 74 and 14 *vs.* 74 per cent. These individual-tree russet percentages had been forecast rather closely by estimates made three weeks previously from superficial examination of the trees ($r = +.743$) but could not be correlated significantly ($r = .136$ or less) with amount of fruit per tree, size of fruit, or scab percentage.

SMALL FRUITS

STRAWBERRY VARIETY TESTS. Russell M. Bailey and Iva M. Burgess. Tests of the following varieties were conducted in 1934: Aberdeen, Bellmar, Big Late, Blakemore, Chesapeake, Dorsett, Fairfax, Gandy, Gibson, Howard Supreme, Jupiter, Pearl, Premier (Howard 17), and Wyona. Some of the varieties did not have an adequate number of plants for a suitable test. However, preliminary observations were made on them. The late varieties as a group were almost a failure probably due to the unusually dry season. In general, the poor response of most of the varieties seemed to emphasize the value of Premier (Howard 17) for Maine. Aberdeen again was promising. Although it was not equal to Premier in berry flesh color or firmness, it ripens at a later date and is an

excellent plant maker. Howard Supreme ripens at about the same date as Aberdeen, is better quality and more attractive, but does not produce plants as freely and has suffered winter injury in our plots. Dorsett and Fairfax were vigorous in vegetative growth but yielded poorly, possibly due to overcrowding.

RED RASPBERRY VARIETY TEST. Russell M. Bailey and Iva M. Burgess. The varieties included in the 1934 test were Chief, Cuthbert, Herbert, King, Latham, Lloyd George, Monroe, Newberg, Newman, and Viking. Practically no winter injury occurred in the winter of 1933-34 while in 1932-33 many of the varieties were badly injured. In consequence, varietal response was somewhat different in 1934 in some instances. In 1933 Viking was almost a complete failure whereas this year it was the outstanding variety in yield. Its high quality and attractive fruit and plant type should make it a valuable berry if it can be protected from winter injury and kept free from disease. These two last mentioned undesirable characters make raising this variety hazardous. Latham is still probably the most dependable variety for market use. Chief also responded well and ripened its fruit earlier than Latham; in other ways the latter variety is superior.

GRAPE VARIETY TEST. Russell M. Bailey and Iva M. Burgess. Varieties that have borne fruit so far at Highmoor Farm are Alpha,



FIG. 49. Beta grapes show considerable promise for southern Maine.

Beta, Caco, Concord, Fredonia, Minn. No. 11, Minn. No. 45, Minn. No. 69, Portland, and Worden. Of these varieties, Beta was outstanding in yield, vigor, earliness, and hardiness. The berries, however, were small and the quality such that it is better adapted for juice and preserving than for table use. Worden, although not as vigorous as Beta, and later maturing, produced large, high quality table fruit. Two of the Minnesota seedlings are very promising, being superior to most of the named varieties in hardiness, early maturity, quality, and vigor.

BLUEBERRY INVESTIGATIONS. *Selection and Variety Testing.* Frederick B. Chandler and Irvin C. Mason. Several of the blueberry clones developed by selection fruited this year. Fruit from several of the low-bush plants was much better than that from the average blueberry plant and compared favorably with that from the cultivated blueberries from New Jersey and Massachusetts. One of the high-bush selections had fruit with flavor and shipping qualities superior in these respects to the cultivated varieties of New Jersey and Massachusetts. Of the cultivated varieties now available none have been selected for Maine conditions. However, three varieties, Adams, Pioneer, and Harding, seem to be worthy of recommendation for commercial use in Maine.

Field Management of the Blueberry. Frederick B. Chandler and Irvin C. Mason. The experiments on burning show that fall burning is as good as spring burning. Fall burning may control sheep laurel if the burning is done every other year. Range oil or kerosene may be used for fuel instead of hay or straw without damage to the blueberry land. Range oil will be more expensive than hay in some sections and cheaper in other sections.

Fertilizers for the Blueberry. Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason. The fertilizer experiments on blueberry land have shown that fertilizers increase the yield of blueberries on land reasonably free from weeds. However, on land which has weeds such as birch, alder, golden rod, sweet fern or grass the yield may be decreased.

Weed Control in Blueberry Fields. Frederick B. Chandler and Irvin C. Mason. Every year we find the low-bush blueberry growing among many undesirable plants. Under such conditions the blueberry has a hard struggle to obtain enough water, light, and plant nutrients to carry out all of its normal processes and produce

a fair crop of fruit. Blueberries cannot be expected to yield their maximum under such conditions. In many fields the common alder and gray birch have nearly crowded the blueberry plants out of existence or have reduced the yield to practically nothing. Some of these fields with alder and birch three or four years old have been cleared or sprouted back in late fall with a view to clearing the land in a few years to make the blueberry more productive. This practice failed to kill the alders and in a few years the job had to be repeated.

Late fall cuttings cannot be expected to control a weed because a plant with a good root system has stored up sufficient plant food to send out the new growth and new leaves for the next year. We established a series of alder plots to be cut at regular intervals throughout the summer season each year for several years. These plots have been cut for three years but the cutting has not stopped the alders from sprouting each year.

To save time and energy in clearing land infested with alder and birch, it would be best to eradicate them completely the first time by removing the entire crown. Most, if not all, of the new sprouts start from the dormant buds on the underside of the old crowns. In alder plots where the crowns have been removed, complete control has been obtained. This method made a final job of alder control. Removal of crowns may take twice as much time at first but the method finishes the cleaning up of the land so far as alders are concerned. In a period of two years since the removal of crowns the blueberries have started to spread into the available open spaces.

Another method of control employs the application of some chemical compound to the freshly cut surface of the gray birch or alder stump and letting its toxic properties work on the living tissues. Common salt has been found to be a means of killing the living stumps with fair success. Salt is cheaper than most of the compounds that are used as weed eradicates and does not have a fire hazard.

Calcium chlorate is too dangerous for the common laborer to handle and somewhat costly but this salt has been used on alder and birch with fair success. Calcium chlorate kills most plants with which it comes in contact.

The laurel plots where the burning system has been practiced for three falls in succession have shown a marked reduction in the number and size of sheep's laurel or lambkill plants. Part of these plots were given fertilizer treatment in addition to the fall burn. On the plots receiving the fertilizer the blueberries have been stimulated greatly and the laurel plants slightly. This stimulation to the laurel has been more than offset by the fall burn so that the laurel has been controlled. The laurel plants on plots burned every other year in the fall show some control, but it will take more than three years to suppress these weeds where they are abundant.

Sweet-Fern Control in Blueberry Fields. Frederick B. Chandler and Irvin C. Mason. This year the sweet-fern plots were cut and the number of plants counted to obtain the percentage control. Several plots cut in July and August showed ninety-five per cent control over a period of years. In order to obtain a good control the sweet fern must be cut several years in succession until its food storage is depleted. This requires also that it be cut in July and August and not in September or October.



FIG. 50. Winnowing blueberries, Washington County. Raked berries are winnowed in the field before delivery to the canning factory. The berries are poured into an opening at the top of the machine, and leaves and chaff are removed by a blast of air as the berries pass over an inclined plane to a box below. Laborers on this farm are paid by the bushel. Each winnows and boxes his berries in half-bushel containers and piles the boxes beside a lath bearing his name.

Diseases of the Blueberry. Florence L. Markin. Heavy defoliation of blueberry plants and dropping of fruits were important in 1934. Undoubtedly much of the defoliation was caused by foliage diseases such as mildew and rust, but the situation was possibly aggravated by other conditions including dry weather during spring and midsummer.

Experiments were continued with fungicidal dusts to control foliage diseases of low-bush blueberries. Comparisons were again made on the time and number of applications, on the year of treatment after burning, and on materials. The fungicides used were copper-lime dust and sulphur dust. They were applied with a hand duster.

As in previous years, copper-lime dust applied the year of burning had no noticeable effect.

Fungicides applied the year after burning, that is, on plants bearing their first crop, again resulted in yields being increased sufficiently to make dusting profitable. The average yield in bushels per acre from the plots receiving each treatment and from the corresponding untreated check plots is given below.

TABLE 13

Yields from Blueberry Plots Receiving Dust Treatments, 1934

Dust	Number of applications ¹	Yield of plots		Increase from dusting	
		Dusted	No dust	Bushels	Per cent
Copper-lime A ²	1	48	28	20	71
	2	76	31	45	147
" " B	1	50	29	21	75
	2	69	34	35	103
" " C	2	74	49	25	50
Sulphur	1	56	43	13	30
	2	67	30	37	122

¹ First and single applications were made near the time blossoms were falling, June 8-9, and the second application over three weeks later. Heavy showers followed the second application.

² Copper-lime dusts A, B, and C consisted of monohydrated copper sulphate, tricalcium arsenate and hydrated lime in the proportions 19-14-67, 38-14-48, and 25-0-75, respectively.

Copper-lime dusts have given good results every year. Sulphur dust has previously increased yields but had not particularly improved the appearance of foliage until 1934.

Plots burned in 1932 and treated in 1933 but not in 1934 yielded more in 1934 than the checks that had never been treated. Plots treated both in 1933 and 1934 showed further increases in yield. However, as in 1933, the second crop was so small that the actual yields were negligible. An example is given of a plot which was dusted in 1933 and part of which was dusted in 1934. Comparisons are made with a check plot which has never been treated. Yields are given in bushels per acre.

Year	Treated	Yield of the plots		Increase in yield of treated plot over the never-treated check	
		Treated	Check	Bushels	Per cent
1933	Yes	44	19	25	136
1934	Yes	1.87	0.67	1.20	178
1934	No	1.34	0.67	0.67	100

When different numbers of applications are compared it is seen that two applications of a fungicide gave better results than one. These results are shown in Table 13.

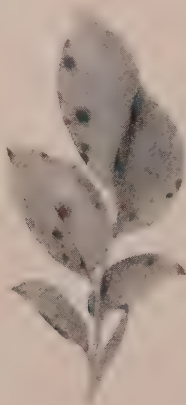


FIG. 51. Leaf rust on blueberry.

The time of application giving the best disease control was again at or following blossom-fall. Comparisons are based on yields of plots dusted at intervals of about a week from June 2 to July 3.

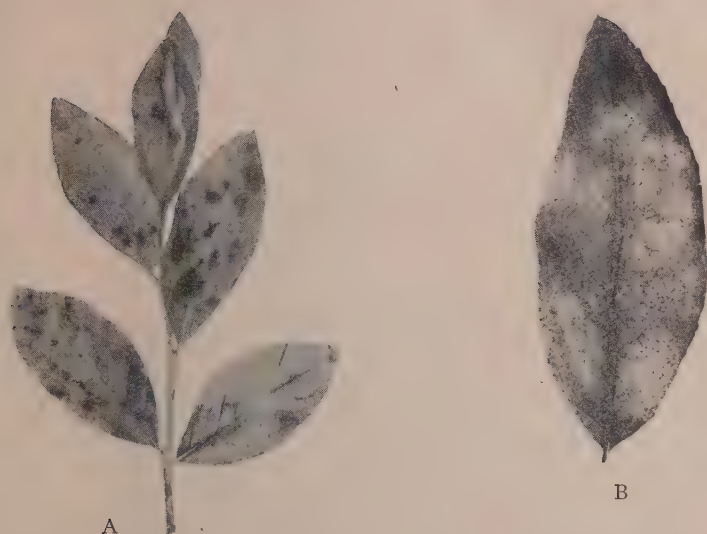


FIG. 52. Powdery mildew on blueberry leaves. (a) Early stage, spotting; (b) enlarged 4x, later stage showing the white mycelium and black perithecia on the leaf surface.

The study of the relationship between leaf and fruit drop, number of fruit buds, and yields, with respect to various treatments, was continued.

CANNING CROPS

SWEET CORN. *Breeding Investigations.* Russell M. Bailey and Iva M. Burgess. An extensive yield trial of sweet corn varieties, double crosses and top crosses, was conducted this year at Highmoor Farm in connection with the breeding work. Ten top crosses averaged 15 per cent greater in yield than the three canners' strains of Golden Bantam and exhibited better uniformity. The average yield of nineteen double crosses tested was only 7.5 per cent above that of the Golden Bantam strains. The crosses were, however, much more uniform and were earlier maturing. Their inferior yield as

compared with top crosses was probably due to the incorporation of several early maturing and poorly yielding inbred lines.



FIG. 53. A seed plot of sweet corn showing the plan for producing hybrid seed. Two rows of a standard variety are alternated with one row of a pure line and the tassels are removed from the standard variety.

Two top crosses which showed a superior response in 1933 were tested coöperatively with four of the largest packers in the State. At each location the hybrids were compared to the Golden Bantam strain that the packer customarily grows. The top crosses outyielded the Golden Bantam check in every case and the average increase was 25.45 per cent.

Fertilizer and Lime Tests with Sweet Corn. Joseph A. Chucka, Russell M. Bailey, and Delmar B. Lovejoy. The 1934 data from the fertilizer and lime experiments with sweet corn at Highmoor Farm were in agreement with previous data. The best results were secured when complete fertilizer was used with both lime and manure. The results obtained with incomplete fertilizer mixtures as compared with complete (mixtures in which nitrogen, phosphoric acid, or potash was left out) showed the greatest reduction in the yield of sweet corn when phosphoric acid was left out, intermediate

reduction when nitrogen was omitted, and the smallest reduction without potash.

With reference to the rate and method of application of fertilizer for sweet corn the results, as in former years, showed that 500 or 600 pounds of complete fertilizer applied in the row gave the best results and that broadcast applications of fertilizer were not profitable when cost of fertilizer and prices received for sweet corn are taken into consideration.

Lime applications were again very effective in increasing sweet corn yields. The highest yields of sweet corn were obtained on the plots which received two 4,000-pound applications of lime during the last four years. However, 1,000-pound applications of lime showed the greatest net return per acre when the cost of treatment was taken into consideration.

The data obtained from these fertilizer and lime tests with sweet corn show very clearly that neither fertilizer nor lime gives the best results when either is used alone. Fertilizers give the best results when used on soils that have received lime applications. Likewise lime applications give better results if followed by fertilizer application than they do if used alone.

Bacterial Wilt of Sweet Corn. Florence L. Markin. The prevalence of bacterial wilt of corn in southwestern Maine in 1933 made it seem desirable to secure new varieties of early-maturing sweet corn resistant to this disease. During the past season, studies



FIG. 54. Corn wilt studies. A plot in which varieties were tested for resistance to bacterial wilt.

were made with sweet corn from a large number of seed sources in an attempt to locate early strains resistant to bacterial wilt. Factors that might influence the appearance of the disease were also studied.

Resistance Studies. The seed used in the studies on resistance came from the following sources: inbred lines and crosses of Golden Bantam corn selected previously by the Experiment Station, canners' strains of Golden Bantam and Crosby, commercial varieties, and miscellaneous sources. From nearly 100 such stocks of seed, small lots of plants were subjected to preliminary tests in the greenhouse. Approximately one-half of the plants of each lot were inoculated. These plants, when about two inches tall, were inoculated in the stalks by means of a hypodermic needle. Several of the inbred lines and crosses withstood the disease satisfactorily.

Corn was grown in plots (replicated when sufficient seed was available) in two fields at Eliot and Kennebunk, where all the plants had been naturally infected in 1933. No inoculations were made in these two plots and natural infection was too light to give results with respect to resistance. A similar planting was made at Highmoor Farm from which place the disease had never been reported. Here the corn was inoculated using the greenhouse procedure again with successful results. In addition to records on growth and symptoms, at Highmoor Farm, records were taken on the number and weight of marketable (canners' choice) and non-marketable ears, comparing the inoculated with the uninoculated plants of each lot. Many of the inbred lines were very susceptible, being killed early and producing few or no ears on the inoculated plants. Most of the lots of corn showed some susceptibility. In the lots that appeared most resistant the only noticeable effect at harvest time was that inoculation had reduced plant height and yield rate slightly. Several of the canners' strains of Golden Bantam, and crosses of these strains with certain inbred lines, were among the most resistant.

General Occurrence of Bacterial Wilt. In 1933, sweet corn was severely infected by bacterial wilt in southwestern Maine, but in 1934 there was little evidence of natural infection. Natural infection was noticeable only early in the season and the plants seemed to recover during the summer. By September, of the hundreds of plants examined on the non-inoculated plots, only a few showed symptoms. The attacks were mild, though resulting in some dwarf-

ing, earliness, and yield reduction. Thus 1934 stood in contrast with 1933 with respect to the disease. The weather preceding and during the two growing seasons also was somewhat different. The winter of 1933-34 was much more severe, with respect to temperature, than the previous one, but there was a heavy snow coverage during the coldest weather. The average temperature for the period from April to September was about the same for the two seasons, but the temperature in 1934 was somewhat higher in April, early May, early June, and July than in the corresponding months of 1933. There was much less rainfall during the 1934 growing season, notably in April, May (except the first week), July and August. The total May, 1934, rainfall exceeded that of May, 1933, but practically two-thirds of it fell during the first few days. The corn was noticeably affected by the dry weather but heavy showers in late July revived the suffering crop.

FIELD BEANS. *Variety Tests.* Russell M. Bailey and Iva M. Burgess.

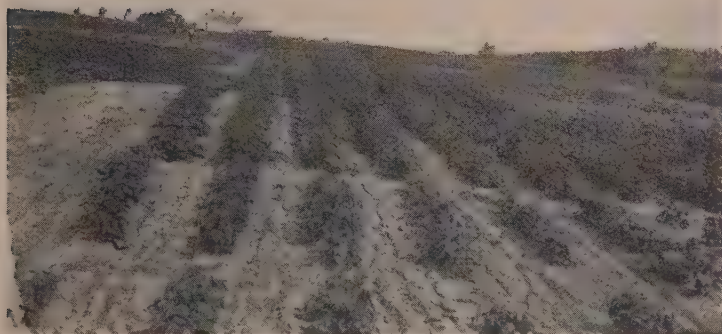


FIG. 55. Bean variety and strain tests at Highmoor Farm.

Old Fashioned Yellow Eye. The runner type Old Fashioned Yellow Eye (State of Maine Yellow Eye) continued to be the highest producing bean variety in the plots. The bush type yielded 38

per cent less but ripened about ten days earlier than did the runner type. In previous years the bush type has been slightly earlier in ripening but not by more than three or four days. Growers who plant in fields subject to early frosts have found this difference in time of maturity to be of some value in determining which Old Fashioned Yellow Eye to plant. The bush type, however, is much more susceptible to blight than is the runner type.

Red Kidney. No new strains were included in the test plots. Blight and anthracnose were severe on all strains but one. That strain, however, produced seeds smaller and of browner color than is desirable in Red Kidneys. Because of the susceptibility to disease and the difficulty in curing so as to obtain seeds of good color, the Red Kidney may be considered of questionable value for large plantings in this State.

Pea Beans. Two new pea beans were included in the test plots this year. These were the Genesee and the Honeoye, both developed in New York. The Honeoye was heavily infected with rust. The seeds were rather large for the pea bean class. The Genesee produced seeds slightly smaller than the Robust and the yield was slightly under that of the latter variety. The Robust and Pilot Navy gave the highest yield of the pea beans. With the exception of last year, Robust has consistently produced the largest crop of pea beans in the test plots.

Fertilizer and Lime Tests with Beans. Joseph A. Chucka, Russell M. Bailey and Delmar B. Lovejoy. The 1934 data from the fertilizer and lime experiments with beans at Highmoor Farm are in agreement with previous data secured. Best results were secured when complete fertilizer was used in connection with both lime and manure. The results obtained with incomplete fertilizer mixtures (mixtures in which nitrogen, phosphoric acid, or potash was left out) showed the greatest reduction in yield of beans when phosphoric acid was left out, intermediate reduction without nitrogen, and smallest reduction when potash was left out.

The data obtained from these fertilizer and lime tests with beans indicate that neither fertilizer nor lime gives best results when either is used alone. Fertilizers give best results when used on soils that have received lime applications. Likewise lime applications give better results if followed by fertilizer application than they do if used alone.

SNAP BEANS. Russell M. Bailey and Iva M. Burgess. No new varieties of snap beans for canning purposes were added to the test plots this year. In general the performance of the various varieties was similar to that of previous seasons. Certain white seeded varieties merit special mention here. Conserva continued to be the lowest producing bean variety in the plot. This season its bearing habit would have been particularly objectionable from a canner's viewpoint. The plants continued to bear throughout the season but every picking was small. Hercules, a round green-podded variety, has been outstanding in its high productivity for the two seasons grown. The pods were long and straight and the individual pickings large. It was somewhat later than varieties such as Stringless Green Pod. The principal objection to Hercules was the tendency for the pods to become somewhat stringy as they became old. When of suitable maturity for snap beans, however, no stringiness was observed. White Seeded Wax was also late and high in production. The pods were rather short but smooth. The canned product was tender and of good quality.

GARDEN CROPS

Variety testing of the various vegetable crops was continued on a similar plan to that of previous seasons. Results of only a few crops which received especial attention will be reported here.

LETTUCE VARIETY TESTS AND HAY MULCH TESTS. Russell M. Bailey and Iva M. Burgess. Twenty-one strains of New York ("Iceberg") lettuce were grown in the test plots during the past season. Plantings were made at times that would bring the crop to maturity during the warmer part of the summer. This was done to learn what strains, if any, could give a satisfactory crop under such unfavorable weather conditions. The resulting crop was rather poor. Plants failed to head well and tipburn was serious. Strains of No. 12 and of Imperial F were, in general, superior to other types. Tipburn Resisting No. 484 and No. 515 did not make a very good showing because of failure to head well.

Some interesting results were obtained from using a hay mulch on a plot of New York lettuce. The records of this one season indicate that the mulch caused a decrease in the amount of tipburn and showed a tendency to induce the formation of better heads. On

the other hand, the average weight of the heads was smaller and the time of maturity was a little later on the mulched plot than on the check plot.

TOMATOES. *Variety Tests and Breeding.* Russell M. Bailey and Iva M. Burgess. In the tomato variety selections and tests two characteristics, earliness and freedom from cracking ("rain cracks"), have been given especial attention. The early crop of tomatoes was unusually good this year. Conditions were such that there was very little trouble from cracking. Because of this the Red River selections which had previously been noticeable for the high yield of early marketable fruit were inferior to some other varieties. Later in the season, however, when fruits were badly cracked these selections showed a high degree of resistance.

Two of the newly introduced varieties were outstanding in early yield. These were Lincoln and Speed. Lincoln was grown for the first time this season. The early yield was high and very little trouble from cracking was experienced. The fruits were smooth and quite uniform in size, but small. Speed has been grown for several seasons and has been found to be one of the earliest varieties. It has sometimes shown a high percentage of badly cracked fruits. The fruits though small were larger than were those of Lincoln. Sunrise, another small fruited variety, although not early, showed only a small amount of cracking. Where the small sized fruits are not objectionable these varieties may be worthy of trial.

Crosses of Red River selections with several other varieties (Bonny Best, Pritchard, Delicious, Marglobe) showed marked increases in early yield over either parent. Within each cross the fruits were uniform in size and shape. In general the Pritchard crosses were superior to the others when considering size and shape of fruit and early yield. There was little or no indication of any effect of the Red River parent in reducing the amount of cracking.

A preliminary trial was made of different methods of training tomato plants. Four kinds of tomatoes each received five different treatments. The treatments were as follows: (1) mulched—a hay mulch was applied between the rows and under the plants, (2) supported—the plants were held off the ground by a wooden frame, (3) natural—the plants were grown naturally on the ground, (4) pruned to three stems and staked—the plants were allowed to grow only three stems which were supported fanwise by a string trellis,

(5) pruned to one stem and staked—the plants were allowed to grow only one stem which was supported by a string trellis. There was some indication that the treatments giving the best early yields were the mulch and the board support. The yields of marketable ripe fruit in pounds for different parts of the season are given below.

Treatment	Aug. 3-16	Aug. 17-31	Sept. 1-25	Total
Mulched	9.0 lbs.	25.4 lbs.	69.3 lbs.	103.7 lbs.
Supported	8.8	24.0	60.2	93.0
Natural	7.5	23.0	57.9	88.4
Pruned 3 stems	7.3	21.7	45.7	74.7
Pruned 1 stem	7.7	21.3	24.3	53.3

The pruned plants could have been set closer together thus increasing the yield obtained from a given area. The supported and natural plots gave the lowest percentage of cracked fruits.



FIG. 56. A Boston pickling cucumber plant severely infected with scab as a result of early artificial inoculation.

CUCUMBERS. *Breeding Studies*. Russell M. Bailey and Iva M. Burgess. Breeding for resistance to scab (*Cladosporium cu-*

cucurinum) has been continued. A large number of selections were made this summer from F_2 populations produced from promising crosses. Further study on these is necessary to determine their individual disease resistance before any can be tested commercially.



FIG. 57. A resistant cucumber plant which was unaffected by the early inoculation.

RUTABAGAS. *Control of Water Heart in Rutabagas.* Frederick B. Chandler, Joseph A. Chucka, and Irvin C. Mason. Water heart of rutabagas has greatly damaged the rutabaga crop in some sections of the State. This year an experiment was started on a soil where water heart has been common. The studies were made from the standpoints of varieties, dates of planting, and dates of harvesting combined with fertilizer treatments. Nine varieties of rutabagas were selected to test their qualities and possibility of their showing a resistance to water heart. No variety tested proved to be entirely free from water heart. The variety Golden Neckless appeared very objectionable on account of water heart and pecky areas throughout the roots. A study of planting dates was made with a planting made every two weeks from June 1st to July 15th or on four dates. The July 1st planting gave the most desirable size of root.

The fertilizers to be studied included the applications of nitrogen, nitrogen and phosphorus, nitrogen and potash, phosphorus and potash, and nitrogen, phosphorus and potash. Barn manure and seaweed were applied alone and in combination with 500 pounds of a complete fertilizer. In addition borax⁷ was applied with 500 pounds of complete fertilizer. The rows treated with fertilizer alone gave water heart in abundance, while the rows treated with 10 pounds of borax per acre were quite free of water heart. Applications of seaweed and manure brought about a reduction in the amount of water heart but did not result in the production of as good crispy rutabagas as those on the plots treated with borax.

APHID INVESTIGATION

APHID INVESTIGATION WITH SPECIAL REFERENCE TO THE RANGE OF FOOD PLANTS. Edith M. Patch. The economic significance of aphids has been increasingly appreciated during recent years since many species of this family of insects have been found to be carriers of plant diseases. To those who are concerned with plant diseases, therefore, as well as to those who are concerned with direct damage by aphids, it is important to know all the species of plants that are susceptible to attack by a given species of aphid. In this connection a catalog of the food-plants of the aphids of the world is in preparation.

WHEAT WIREWORMS

WIREWORMS IN MAINE SOILS. John H. Hawkins. Wireworms inhabit the soil of fields and gardens over the greater part of Maine. Soils of nearly every type are infested. On the whole wireworms are most abundant in soil in which clay is predominant and in low lying areas where the soil does not dry out readily. However, one species is known to inhabit the sandy soils of the river valleys. Certain areas where the soil is a light loam usually escape infestations by these insects.

⁷ Dr. D. J. MacLeod of the Dominion Experimental Farm, Fredericton, New Brunswick, in 1933 discovered that borax prevented the occurrence of water heart in rutabaga.

Wireworm injury to plants in Maine is often underestimated. The injury done by these insects is of such a nature that it often passes unnoticed or is attributed to other causes. There are many ways in which plants are injured. Seeds planted in the soil are often injured so that germination is impaired. After the seeds have germinated the roots and the tiny new plants may then be killed by wireworms. Older plants may be affected by wireworms feeding upon the roots. During severe attacks all the roots may be destroyed and even the underground portion of the stems eaten away. Potato tubers, dahlia roots, corms of gladiolus, onions, and rhizomes of grasses are all attacked by wireworms. The fruits of the tomato, pumpkin, and muskmelon are subject to attack when left in contact with the soil.

The plants in the following list have been observed to be attacked by wireworms in Maine.

FIELD CROPS	VEGETABLE AND FRUIT CROPS	
Barley	Apple	Muskmelon (fruit)
Buckwheat (common)	Bean (bush lima)	Onion
Clover (alsike)	Bean (common bush)	Pea (garden)
Clover (red)	Beet	Potato
Corn	Cabbage	Pumpkin (fruit)
Oat	Carrot	Radish
Potato	Cauliflower	Rutabaga
Red Top	Cucumber	Spinach
Rye	Eggplant	Squash (winter)
Timothy	Endive	Strawberry
Wheat		Tomato
ORNAMENTALS	WEEDS	
Aster	Charlock	Plantain (common)
Columbine	Dandelion (common)	Radish (wild)
Dahlia	Grass (barnyard)	Rutabaga (wild)
Gladiolus	Grass (couch)	
Lupine	Grass (foxtail)	
Phlox		

Plants vary greatly in their susceptibility to wireworm attack. Members of the grass family, including many of our common grasses and grains such as timothy, red top, couch grass or witch grass, oats, and corn are very susceptible to wireworm attacks.

Although meadow grasses or grains sown broadcast are sometimes severely injured, they usually survive unless wireworms are present in overwhelming numbers, because a relatively larger number of plants grow within a given area. Corn planted in hills is apt to be destroyed or greatly injured when wireworms are abundant. Sweet corn was greatly reduced in yield in a field at Holden, Maine, during 1934 where 62 wireworms per square yard were present. Ensilage corn drilled so that the plants are close together will withstand the attack of a greater number of wireworms than corn planted in hills due to a greater number of plants in drilled rows.

Of crops commonly grown in Maine, beans, peas, clover, and buckwheat are among the least susceptible to wireworm injuries. For this reason if many wireworms are present in the soil these are good crops to grow until such time as these insects are reduced to such numbers that more susceptible crops can be grown with safety.

Life History and Control of the Wheat Wireworm. Although a general idea has long persisted that the wheat wireworm required about three years to complete its life history, no record of its having been reared from egg to adult can be found. In order to apply control measures effectively, it is essential to have definite knowledge of the time and duration of the various stages. Larvae of the wheat wireworm have now been reared from the egg to the adult stage and data thus obtained along with field observations form the basis for the life history chart shown in Fig. 58.

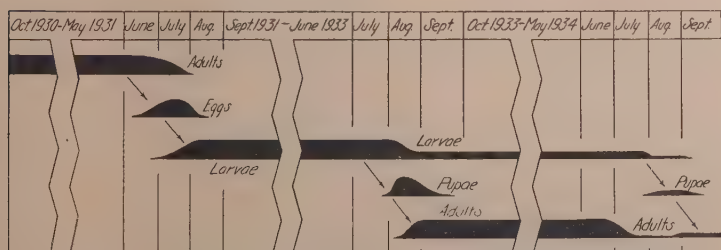


FIG. 58. The life history of the wheat wireworm, *Agriotes mancus* Say. This species is the most common and destructive wireworm in Maine.

The adults of the wheat wireworm, *Agriotes mancus* Say, are small brown elaterid beetles, sometimes called snapping beetles or

skipjacks. They hibernate in the soil or elsewhere about the field and become active in early spring. The eggs, laid from early June until August (Fig. 58), hatch in about two weeks. The tiny newly-hatched wireworms are so small that they can scarcely be seen without a magnifying glass. The wireworms spend the first season and two or three additional years in the soil before they mature and emerge as adult beetles.

Keeping the land in cultivation from the time the soil can be worked in the spring until the end of the egg laying period, about the last of July (Fig. 58), is good practice for the control of the wheat wireworm. Weeds and grass which might serve as shelter and food for the adults are destroyed by cultivation of the soil. Stirring of the soil routs the beetles from their hiding places in or near the surface of the soil. Careful field observations have led to the conclusion that most of the female beetles leave cultivated fields for nearby uncultivated areas where the eggs are laid. It is rare to find first year larvae of the wheat wireworm in cleanly cultivated fields. Cultivation directly affects only a small portion of the older larvae of this species and pupae and adults in the soil often survive fall plowing. Cultivation at any time of the year, however, aids the control of the wheat wireworm and stirring of the soil during spring and early summer is especially recommended. It has been found that cultivation is a practice which may be used for greatly reducing the numbers of wireworms in infested fields even within a year's time. If carried on over a period of years, cultivation continues to be effective until the wireworms are practically eradicated from the soil. Cultural control has the advantage over many other methods of insect control in that no extra labor or materials are required. Soil once freed from wireworms by cultivation does not ordinarily become infested again unless the land is seeded to hay or grain crops. Soil left in grass crops for two or three years after being freed of wireworms is very likely to become reinfested.

It is impossible to make a general recommendation, for crop rotations to be used in wireworm control, which would suit all conditions and crops in Maine. Where potatoes are to be grown, some other crop should intervene between the breaking up of grass-land heavily infested by wireworms and the planting of potatoes. It may be necessary to grow other crops for as long as three years

before it is safe to plant potatoes. Cultivated peas and beans can be grown in very heavily infested soil and should be grown as long as it is necessary to reduce the population of wireworms to such an extent that other crops may be grown. Corn can usually be grown safely after two cultivated crops follow the plowing of grassland even where there was originally a large wireworm population. Corn can sometimes be successfully grown after one cultivated crop has been raised following the plowing up of grassland. In wireworm control it is worthy of note that any cultivated crop is to be preferred to a broadcast crop with the possible exception of buckwheat. Where it is possible to work the soil at regular intervals and plant buckwheat late in the season this crop is almost ideal, for if cultivation is carried on until July 10 or 15 most of the danger of reinfestation by the beetles laying eggs in the field is past before cultivation ceases. Where wireworms are abundant, buckwheat might be preferable to crimson clover which is grown as a green manure crop in potato rotations and must be planted early to make a good growth. Crimson clover is a good crop to grow in soil subject to wireworm infestation because it stands but one year and there is little time for the adults to initiate a new generation. A crop of crimson clover grown once in two or three years is recommended. Most crops can be planted with relative safety in soil after three years of cultivation and after that the kind of rotation makes little difference in wireworm control so long as a broadcast grain crop is not used too often and the soil is not again seeded to grass.

NUTRITION OF CHILDREN IN MAINE

A STUDY OF THE FOOD HABITS AND THE NUTRITIONAL STATUS OF CHILDREN IN SELECTED COMMUNITIES IN MAINE. Mary M. Clayton and Marion D. Sweetman. The object of this project is to investigate the nutritional status of Maine children of grade school age and their food consumption habits. This information will be employed (1) to provide a basis for appropriate educational programs and remedial measures, and (2) to provide a basis for further nutritional research which may include such investigations as that of the particular nutritive qualities of locally grown plants and locally produced animal food and that of their improvement.

Concentrated studies are being made in towns which have been chosen as being apparently typical of conditions over a large area where agricultural, industrial, and climatic conditions are similar. The following towns have been selected :

1. Mars Hill, in the potato district of Aroostook County.
2. Jonesport, a typical fishing town in Washington County.
3. Monmouth, in a general farming region of Kennebec County.

Work this fall has included the making of complete physical examinations of 677 children. Each examination has included various physical measurements, an examination of the teeth, determination of hemoglobin, and tests for vitamin A and C deficiencies. The assistance of Amy Louise Hunter, M.D., and the coöperation of Dorothy Bryant, Director of Dental Hygiene for the State of Maine Department of Health, and Mark Elliott, D.D.S., of the Forsythe Dental Clinic in Boston, have been secured for these examinations. The plan is to repeat the examinations on the same children in the spring. During the winter months dietary data will be secured through home visits.

A preliminary tabulation of the records secured shows a high incidence of bone and tooth defects in all of the three localities studied. In one of the towns, among the 200 children examined only one was not in need of immediate dental treatment. Regarding the condition in this town Dr. Mark Elliott reported, "In many dental surveys in various parts of the country I have never seen anything to compare with the deplorable dental condition found among the school children of this town." The average number of unrepaired cavities per mouth was 12.8. In another of the three towns this average was 10. The average number of fillings in both was less than 1. Dental data for the third town have not been tabulated.

Results of hemoglobin determinations varied in the three towns, 33.8 per cent of the children examined in one having hemoglobin readings below 80 per cent of normal, while only 1.9 per cent of the children had such readings in the town having the highest average. At this season the capillary resistance test indicated little vitamin C deficiency. In one of the towns the incidence of colds and enlarged tonsils was especially high.

While analysis of the records taken is not complete it seems fair to conclude that Maine school children exhibit many physical defects of types which have been shown to be related to diet or sunlight, and in the case of deficiency of the latter, preventable by dietary measures. Collection and analysis of dietary records and experiments with various supplements to the ordinary food supply are needed to form the basis for specific recommendations.

FAMILY FINANCING OF HIGHER EDUCATION

A STUDY OF THE FINANCING BY MAINE FAMILIES OF THE HIGHER EDUCATION OF THEIR CHILDREN IN MAINE INSTITUTIONS. Pearl S. Greene. Some additional data have been collected in this project, and their analysis has been begun with a view to collecting, by correspondence with parents, further briefer records of the most essential material. Preliminary analysis indicates that parents of prospective students need more information not only of the costs of tuition, room and board, but of the range of incidental expenditures as influenced by student standards of living on the campus; and that small families of low or moderate income need help in planning family finances to distribute the peak cost of higher education somewhat more comfortably over a period of years by means of savings made specifically for education. Certain indications regarding the range and distribution of income of the Maine families who send children to the University have implications of so much importance as a basis for policies in such matters as self-help dormitories, scholarships, and loan funds, that further data will be sought to establish valid conclusions.

ELECTRICAL COOKERY

Electrical Cookery. Merna M. Monroe. The present nationwide trend toward making electric energy available at low rates for household use in rural as well as in urban areas has made the electrical project of the Department of more immediate interest than at first appeared. The rapid development of equipment at a wide range in cost has increased the importance of the type of information on efficiency which has been and is being collected.

As was the case in the early history of experiment stations, when the researcher protected the interests of the farmer by setting up standards for fertilizers and by analyzing commercial products in the light of those standards, so the type of work being done in this project, and being developed in other stations, is protecting the consumer. This is educating her, and is bringing to the attention of the alert manufacturer and distributor of equipment the problems of the consumer, through criticism of his product in the light of consumer standards.

The most important efficiency approach to the problem under present conditions appears to lie in the relation of the characteristics of the food container to the predominant mode of heat transmission of the surface or oven unit. A new method which reduces somewhat the variables in surface cookery has been developed, and is being used with satisfactory results to test the effectiveness of various combinations of utensil and surface unit. Special oven equipment has been devised for the same purpose.

The study of the baking performance of some small, inexpensive, non-insulated, low wattage ovens has been completed. The method of heat transfer in these ovens differs somewhat from that in the ordinary household oven; heat is received from below by conduction from a hot metal shelf and from above by radiation from electric heating coils. Oven temperature is controlled by raising or lowering the upper heating coil; there is no temperature indicator or regulator. Because of these features of construction, standard baked products could be obtained with certain types of foods only, such as fruit pies and biscuits; acceptable but not standard products were obtained with ice-box cookies, plain cake, muffins, baked potatoes, and baked custards; and inferior products were obtained with roast pork which lost considerable weight and was drier and less palatable, and with non-shortened cake which was tough.

For short-time processes the cost of using these ovens to bake small quantities of food, such as a tin of muffins, a sheet of biscuits, or a fruit pie, was considerably less than that of pre-heating and baking in an ordinary electric range oven, assuming that in both instances the rate paid for electrical energy was the same as would be the case when they are based upon a scaled plan. For comparatively long-time processes, such as baking potatoes, the

cost of using these non-insulated ovens was slightly more than that of the household oven.

Such an appliance, if sturdily constructed, may be useful in the small household where there is frequent demand for short-time use of the oven for a single food. If it is accompanied by a small, sturdy electric hotplate, the small family might use electricity for part or all of its cooking in hot weather or in furnace heated rooms at a comparatively low initial cost.

MARKET AREA STUDIES

LOCAL MARKET CONDITIONS AND REQUIREMENTS OF AGRICULTURAL PRODUCTS IN MAINE (EXCEPT AROOSTOOK COUNTY). Charles H. Merchant. This project was begun in July, 1932, to study local market conditions and requirements in the various parts of the State in order to assist farmers in adjusting their agricultural production to more nearly meet these conditions and requirements where it seems feasible. During the summers of 1932 and 1933, as reported in Bulletin 369,⁸ information was collected from stores, hotels, restaurants, and camps on purchases of agricultural products and from farmers as to crops grown and livestock kept.

During the summer of 1934, additional information was collected in the southwestern part of York County and five towns in Cumberland County. The towns studied in Cumberland County were Baldwin, Gray, New Gloucester, Standish, and Windham. A study of the material collected during the first two years indicates clearly that there are many problems involved in this study other than those which may be logically included under marketing. Of the many problems, the most important is probably that of the future use of the land resources in many areas of York and Cumberland Counties.

It has been found that a general survey of farm buildings and conditions afford an approximate measure or indicator of the relative profitableness of agriculture within a region. One of the principal factors affecting the profitableness of a region is the soil type. Inasmuch as a soil survey had been made in Cumberland County, it was decided to continue the field work in this County

⁸ Report of Progress, Me. Agr. Exp. Sta. Bulletin 369, p. 516.

during the past summer. Information was obtained from farmers and town officials, and from a road survey of general conditions. Data collected include size and condition of farm buildings, location of farm in respect to markets, soil type, topography, and conveniences such as telephone and electric lights, on each farm in the five towns. An attempt is being made to associate the various types of farming and the apparent relative profitableness of farming with such factors as soil type, distance to markets, condition of roads, and several other important factors.

Information collected during the past three summers is partly tabulated and analyzed at the present time. The work on this project thus far clearly indicates the need of a comprehensive soil survey of our agricultural areas of the State. The problems which are involved in this type of study fall very largely in the field of land utilization. After the work in these two counties has been completed, it may be advisable to discontinue this type of study at least until a comprehensive soil survey has been made.

FARM CREDIT IN MAINE

AGRICULTURAL CREDIT IN MAINE. Charles H. Merchant. This project was begun on July 1, 1934. The first phase of the work was to ascertain the material which was readily available in the State on agricultural credit. In this connection the coöperation of the Extension Service of the University of Maine and the three Production Credit Associations in the State was secured. During the past summer (summer of 1934) considerable information has been obtained from these two coöperating agencies. The information thus far obtained covers the credit needs of the farmers in the various sections of the State, sources of credit, and conditions (interest rates, securities, and other conditions of the loans) under which loans are made by each credit agency.

Accurate records of farm expenditures and receipts of nearly 60 farmers for each of the three years 1931, 1932, and 1933 are being analyzed to ascertain the credit needs of farmers in the various sections of the State during each month of the year. This information is being assembled in detail for three types of farming: potato, dairy, and general. Similarly, information although

not as complete in detail, is being summarized for poultry and apple farmers.

During the past summer, information was also obtained on the farm organization and financial status of 731 farmers of the State. Of this number, 538 were Aroostook potato farmers, 77 potato growers in central Maine, 34 dairy farmers, 21 poultry raisers, and 61 general farmers. The farm organization includes information on the crops grown and the livestock kept on each farm. The financial status of the farmer includes the valuation of his farm, livestock, machinery, and farm products to be sold as well as his cash on hand and other assets. Also under the financial status is included a detailed description of all debts. The information concerning debts includes the sources of credit, securities, rates of interest, and other conditions under which loans were made. It should be interesting to note that many farmers are paying interest rates in excess of eight per cent where the money could be borrowed from other sources at much lower rates of interest with less security in many cases and often on a more satisfactory basis for repayment. Every farmer should study his own situation and make improvements in his credit conditions where needed.

CHEMISTRY INVESTIGATIONS

Work of Investigations. Elmer R. Tobey. The work of this department is coöperative with members of other departments in the Station. The usual amount of work with feeds in connection with the problem of nutrition and growth in poultry has been carried on during the past year. In connection with plant nutrition problems in Aroostook County approximately thirty samples of soil, from fields on which notes in regard to magnesium deficiency have been taken and on a part of which crop yields are available, have been examined to determine the amounts of replaceable manganese, replaceable calcium, and replaceable magnesium in order to study the relation of the amounts of these replaceable elements to the extent of magnesium deficiency as indicated by magnesium deficiency symptoms and by known responses to applications of magnesium on the fields from which these samples were taken. The results of these determinations will be incorporated in the final published reports of the respective projects.

INSPECTION SERVICE

Work of Inspection Service. James M. Bartlett, C. Harry White, Bernie E. Plummer, Glenn H. Perkins, and George P. Steinbauer. The time of this department has been almost wholly occupied in making the analyses required by the Commissioner of Agriculture, who is the executive of the laws regulating the sale of foods and drugs, feeding stuffs, fertilizers, agricultural seeds, insecticides and fungicides.

FOOD AND DRUG INSPECTION. For this inspection five hundred and seven samples were analyzed. The results were published in Official Inspections 151, a bulletin of 28 pages. Several unofficial samples of milk, cream, and vinegar, sent in by farmers, were tested and the results not published. Forty-three samples of blueberries from fields that had been dusted with calcium arsenic were tested for arsenic spray residue.

TESTING OF DAIRY GLASSWARE. Under the State law all Babcock glassware used for testing milk or cream by creameries, ice cream manufacturers, or other parties buying or selling milk or cream on a basis of the milk fat content, must be tested for accuracy by the Experiment Station. One thousand one hundred and thirty-one pieces were tested and all passed.

FEEDING STUFFS INSPECTION. One thousand and twenty-seven official samples were analyzed. An effort was made to get at least one sample of every brand sold in the State.

The results of the analyses were published in Official Inspections 152, a bulletin of 48 pages.

FERTILIZER INSPECTION. Four hundred and twenty-one samples of fertilizer material were analyzed. The kinds of material and the results of the analyses are given in Official Inspections 153, a bulletin of 32 pages.

INSPECTION OF AGRICULTURAL SEEDS, INSECTICIDES AND FUNGICIDES. During the year 1934, 144 official samples of seeds were tested. Seedsmen and farmers sent in a total of 91 samples for germination and purity tests, making a total of 235 samples tested during the year.

The samples sent in for test by the Division of Inspections included:

Alfalfa	3 samples	Japanese millet	13 samples
Alsike clover	15 "	Lettuce	2 "
Barley	2 "	Mammoth clover	3 "
Beet	7 "	Oats	7 "
Bent grass	1 sample	Orchard grass	1 sample
Bluegrass (Ky.)	3 samples	Parsnip	1 "
Buckwheat (Jap.)	5 "	Red clover	16 samples
Corn	8 "	Red top	12 "
Crimson clover	5 "	Sudan grass	1 sample
Fescue	1 sample	Timothy	20 samples
Grass mixtures	3 samples	Wheat	2 "
Hungarian millet	10 "	White clover	1 sample
		White sweet clover	2 samples

Forty-nine samples of insecticides and fungicides were collected and analyzed. The results of the examination are given in Official Inspections 154, in conjunction with the results of the examinations of agricultural seeds.

GASOLINE AND MOTOR OIL INSPECTION. The State Tax Assessor is the executive of the law regulating the sale of motor gasolines and oils and the Experiment Station is required to make the analyses.

Gasoline. One hundred and sixty-four samples of gasoline were received and analyzed in 1934. Four samples were found to require a higher temperature for complete distillation (more than 437° F.) than allowed by the Statutes. Several samples marked ethyl did not have the characteristic red color which ethyl gas is supposed to carry; these were probably either substitutes or mixtures.

Motor Oil. One hundred and thirty-nine samples of motor oils were received and examined. Sixteen of them failed to meet the specifications required by the brands claimed for them. In most cases they were good oils but either a heavier or lighter grade than claimed. One sample, however, appeared to have some kerosene mixed with it. The oils on the whole are very much better than those found a few years ago, and there is apparently less substitution now than formerly.

ANNOUNCEMENTS

COUNCIL AND STAFF CHANGES

Council:

Dr. Arthur A. Hauck succeeded Dr. Harold S. Boardman as President of the Station Council, effective July 1, 1934.

Station Staff:

Agricultural Economics—Mr. Merton S. Parsons, Assistant Economist, resigned February 8, 1934. Mrs. Dorrice Myers, Assistant, resigned January 16, 1934, and was succeeded by Miss Iris M. Williams under date of October 16. Mr. Andrew E. Watson was appointed as Graduate Student Assistant, appointment effective July 1, 1934.

Biology—Dr. Delmar S. Fink was appointed as Assistant Biologist, appointment effective July 1, 1934.

Entomology—Dr. Frank H. Lathrop was appointed Entomologist, appointment effective August 1, 1934.

Home Economics—Dr. Mary M. Clayton was appointed as Nutritionist, appointment effective September 1, 1934.

Dr. Joseph A. Chucka, Associate Biologist, and Mr. George F. Dow, Associate Agricultural Economist, were appointed as part time teachers in the College of Agriculture.

PROJECTS FOR 1934

AGRICULTURAL ECONOMICS

An economic study of the dairy industry in Maine.

An economic study of the potato industry in Maine.

Local market conditions and requirements of agricultural products in Maine (except Aroostook County).

Agricultural credit in Maine.

BIOLOGY

The relation between shape and yield of apple trees.

Breeding new varieties of apples.

Nursery stock investigations in relation to bud selection in the apple.

- A study of the cause and possible control of "leaf scorch" of apple trees.
- Causes of cross and self sterility in certain plants, particularly the apple, through a cytologic and genetic study.
- A study of the fertilizer requirements of the native Maine blueberry.
- Breeding investigations with the blueberry.
- Blueberry field management.
- Fruitfulness in the blueberry.
- Weed control in blueberry fields.
- The mode of inheritance of milk production and associated characters in cattle.
- Breeding investigations with garden crops.
- Fertilizer experiments with potatoes in rotation with grain and clover.
- A study of clover failures in a potato rotation.
- A study of various green manuring crops as a means of increasing and maintaining the organic matter content of potato soils in two-, three-, and four-year rotations.
- A study of soil conditions and other factors affecting development and control of potato scab.
- A study of the physiology of reproduction in poultry.
- Influence of anti-rachitic substances on growth in poultry.
- The prevention of water heart in rutabagas and browning in cauliflower.
- Fertilizer experiments with sweet corn and beans in a four-year rotation—oats, clover, sweet corn, and beans and with sweet corn in a two-year rotation—sweet corn and an annual green manuring crop (mixture of oats and peas).
- Inheritance of certain characters in relation to yield and quality in sweet corn and beans.
- Cytological studies in species crosses.
- Small grain variety test including oats, barley, and wheat.
- Breeding investigation with small fruits, particularly raspberries and strawberries.
- A study of methods of improving fertility in orchard soils.

CHEMISTRY

INSPECTION

- Inspection of feeding stuffs.
- Inspection of fertilizers.
- Inspection of foods and drugs.
- Inspection of fungicides and insecticides.
- Inspection of seeds.
- Inspection of gasolines and oils.
- Calibration of creamery glassware.
- Inspection of milk and cream.
- Miscellaneous analyses.

INVESTIGATION

Chemical composition of cows' milk in parents and hybrid offspring.

(In coöperation with the Biology Department.)

Chemical analyses in connection with the problem of nutrition and growth of poultry and dairy cattle. (In coöperation with the Biology Department.)

Soil analyses investigation and analysis of materials used in connection with the permanent rotation and fertility experiments at Aroostook Farm. (In coöperation with the Biology Department.)

Miscellaneous analyses.

ENTOMOLOGY

Aphid investigations with special reference to the different food plants of migratory species.

A study of apple maggot problems including dispersal.

Insects affecting the blueberry.

The cabbage maggot.

Experiments with sodium and calcium fluosilicates in the control of the cucumber beetle and other insects.

Cutworms affecting field and garden crops.

Insects in relation to the transmission of virus diseases of potatoes.

Garden slug control.

Wireworms affecting field and garden crops.

The Mexican bean beetle.

The carrot rust fly.

HOME ECONOMICS

The economic utilization of electricity in food preparation in Maine rural homes.

The factors affecting the cooking quality of potatoes.

A study of the financing by Maine families of the higher education of their children in Maine institutions.

Food habits and nutritional status of children in selected communities in Maine.

PLANT PATHOLOGY

Apple scab control.

Blueberry diseases.

Cucurbit disease control.

Differentiation and dissemination of potato virus diseases.

Dusting and spraying potatoes.

Economic effects and control of potato virus diseases.

Histology and ecology of potato tuber rots.

Identification and dissemination of causes of potato rots.

Seed disinfection of potatoes.

Stem-end browning of potato tubers.

Plant disease survey and miscellaneous diseases. Annual recording, through correspondence and observations, of the prevalence and severity of plant diseases, and preliminary experiments on miscellaneous diseases that develop importance.

PUBLICATIONS

The Station is organized so that the work of investigation is distinct from the work of inspection. The results of investigation are published in the bulletins of the Station and in scientific journals, both foreign and domestic. The bulletins for the year make up the annual report. The results of the work of inspection are printed in publications known as Official Inspections. These are paged independently of the bulletins and may be bound with the annual report as an appendix thereto. Miscellaneous publications consisting of newspaper notices of bulletins and newspaper articles which are not paged consecutively and for the most part are not included in the annual report, also are issued during the year.

BULLETINS ISSUED IN 1934

- No. 370. Isolated Tuber-unit Seed Plots for the Control of Potato Virus Diseases and Blackleg in Northern Maine. 32 pages.
- No. 371. A study of Factors of Economy in Electrical Cooking of a Typical Day's Meals in Maine. 56 pages.
- No. 372. A Survey of the Cooking Practices in Maine Rural and Village Households. 20 pages.
- No. 373. An Economic Study of the Collection of Milk and Cream in Maine. 38 pages.
- No. 374. Costs and Returns in Operating Milk and Cream Collection Routes in Maine. 44 pages.
- No. 375. A study of the Causes of Nutritional Deficiency Diseases in the Livestock and Inhabitants of Maine with Possible Corrective Methods Secured from the Utilization of Maine Fishery Products and the Production of Superior Foods. 96 pages.
- No. 376. A Primer of Electricity and Heat. 36 pages.
- No. 377. Summary Report of Progress 1934. 104 pages.

OFFICIAL INSPECTIONS ISSUED IN 1934

- No. 151. Foods and Drugs. 28 pages.
No. 152. Commercial Feeding Stuffs, 1933-34. 48 pages.
No. 153. Commercial Fertilizers, 1934. 32 pages.
No. 154. Commercial Agricultural Seeds, 1934. Fungicides and Insecticides, 1934.

ABSTRACTS OF PAPERS PUBLISHED BY THE STATION IN 1934 BUT
NOT INCLUDED IN THE BULLETINS

A complete list of all the Bulletins issued by and from the Station in 1934 is given on page 417 of this Report. The following pages contain abstracts of the papers published during the year and not included in the Bulletins or Official Inspections.

THERMAL EFFICIENCY OF COOKING UTENSILS AS AFFECTED BY
VARIATIONS IN THE AREA OF THEIR CONTACT WITH THE
HEATING SURFACE*

Utensils purchased on the open market as identical may or may not have similar thermal efficiencies when used on a closed unit. The difference in thermal efficiency is believed to be caused by the differences in levelness of the bottom surface of the pans. An idea of the extent of contact secured when a pan is placed on a closed heating unit was obtained by painting the bottom of the pan, placing it on the unit, and blotting up the imprint of the paint left on the unit. Such imprints showed that of the pans tested in this laboratory only a very small area of the pan touched the unit. In addition to the differences in areas of the pan which touch the unit, there remain the differences in thickness of the air film in the non-contacting areas.

In an attempt to improve upon the levelness of the bottom of a cast-aluminum kettle under test, the bottom surface was machined. Such treatment permitted a saving of 18.7 per cent in the electrical energy required to heat equal quantities of water. The saving obtained with the unit alone machined was less marked, 7.7 per cent.

* This is an abstract of a paper by Merna M. Monroe and Lolie Smith having the same title and published in the Jour. Home Econ. 26:42-45, 1934.

(An untreated cast-iron frying pan tested on the machined unit required 7.9 per cent more electrical energy than was needed on the unmachined unit.) The use of the machined kettle on the machined unit gave a saving of 25.4 per cent in electrical energy. To ascertain whether, for experimental purposes, the variable of differences in levelness of the bottom surface of utensils might be eliminated, two more cast-aluminum kettles of the same model were machined. These gave comparable results.

STIMULATION OF POTATOES BY MAGNESIUM BORDEAUX SPRAY*

Standard (calcium) Bordeaux mixture has failed to stimulate growth and increase yield of potatoes in Aroostook County in the absence of insects and diseases. In comparison, magnesium Bordeaux increased the yield as much as 96 bushels an acre or 343 per cent on soil deficient in magnesium.

COMPONENTS OF POTATO MILD MOSAIC†

Mild mosaic of Green Mountain potatoes consists of two components. One is latent (masked) in this and other varieties and is not transmitted by aphids. These insects transmit the second component, which is manifested on a seedling potato resistant to the latent component and on a latent-free Green Mountain seedling by light green and slightly rugose leaves. Mild mosaic was demonstrated either by inoculating the second component into Green Mountains which harbored the latent component, or by inoculating healthy Green Mountain seedlings with both components.

GROWING SEED POTATOES UNDER AN ASTER CLOTH CAGE‡

Healthy potato tuber lines or clones grown in the open at distances of one-third to one-half mile from other potatoes, acquired mosaic, spindle tuber, leafroll and yellowtop. An aster cloth cage

* This is an abstract of a paper by Reiner Bonde having the same title and published in *Phytopath.* 24:3. 1934.

† This is an abstract of a paper by E. S. Schultz, R. Bonde, and W. P. Raleigh, having the same title and published in *Phytopath.* 24:17. 1934.

‡ This is an abstract of a paper by Donald Folsom having the same title and published in *Amer. Potato Jour.* 11:65-69. 1934.

covering one-fifth acre protected 28 barrels or 75 bushels of seed from aphid-carried virus at least through July. Experience indicated the need of certain precautions, some of which should extend the period of protection. The cost of materials and labor to protect three-tenths acre is estimated to be less than \$200 a year if the project is carried over several years.

POTATO SPRAYING—THE VALUE OF LATE APPLICATIONS AND MAGNESIUM-BORDEAUX†

In some years in Maine, injury by late blight of potatoes is severe in spite of efforts by growers to prevent it. Surveys and experiments showed that late-blight control was improved and yield increased by the later spray applications of the season. In some depleted soils the use of a magnesium lime in place of a calcium lime in Bordeaux spray enabled the plants to recover from magnesium-deficiency sickness and to yield considerably more.

RESISTANCE OF POTATO TO MOSAIC AND OTHER VIRUS DISEASES*

From 1924 to 1930, 33 new seedling varieties of potato and three commercial varieties were found to be all similarly susceptible to spindle tuber. In five seasons 18 potato seedlings were found to be similarly susceptible to leafroll. Both diseases spread more in 1929 than in other seasons. These tests were made in northern Maine. Streak (also called stipple streak and acropetal necrosis) had less severe effects on Spaulding No. 4 than on Green Mountains, and one variety is a carrier of this disease in masked form. Latent mosaic (also called seedling streak, top-necrosis, and acronecrosis) is carried in masked form by the Green Mountain, Irish Cobbler, and Bliss Triumph varieties and by others, in a high percentage of plants, but seedling No. 41956 is resistant to this disease, even in

† This is an abstract of a paper by Reiner Bonde having the same title and published in Amer. Potato Jour. 11:152-156. 1934. It also represents a similar paper by Reiner Bonde published by the Eastern States Farmers' Exchange, Springfield, Mass., in Eastern States Cooperator 10 (6):6, 22. 1934.

* This is an abstract of a paper by E. S. Schultz, C. F. Clark, Reiner Bonde, W. P. Raleigh, and F. J. Stevenson having the same title and published in Phytopath. 24:116-132. 1934.

tuber-grafts. The only proved means of transmission of latent mosaic in the field is contact of plants; this means is readily effective. Irish Cobblers and Spaulding No. 4 are resistant to mild mosaic. Seedlings No. 24642 and No. 40568 were almost completely resistant to that disease in preliminary field tests. Crosses between these two seedlings produced other seedlings some of which were more resistant than No. 24642 to mild mosaic in further, more exacting field tests. One of them, No. 42667, named Katahdin, in tuber-grafts showed a high degree of resistance to mild mosaic, but was susceptible to latent mosaic. With this progress, and with the results showing genetic segregation for resistance to certain mosaics, it seems certain that satisfactory control of at least two mosaics will be secured through the development of resistant new varieties that are desirable with respect to other economic characteristics.

POTATO VIRUS DISEASES IN 1933*

Natural dissemination varies from place to place and apparently can occur for a half-mile or more. There seems to be no practical rapid method of tuber-indexing without growing the plants. Practical control is making progress through seed plots and other methods. Seed stocks are being increased that are free from masked mosaic and streak diseases. Giant hill is unsolved as to cause. The evidence tends to show that some but not all forms of internal spotting or browning of tubers are due to virus diseases.

POTATO SPRAY SERVICE IN AROOSTOOK COUNTY, MAINE†

This paper describes the "Potato Spray Service" as conducted in Maine through the coöperation of the Extension Service and the Experiment Station workers. The value and popularity of this spray service can best be determined by its steady growth and the

* This is an abstract of a literature review by Donald Folsom, having the same title and published in the Amer. Potato Jour. 11:235-242. 1934. Here are given only the contents of most interest to Maine growers.

† This is an abstract of a paper by Reiner Bonde having the same title and published in The Extension Pathologist for November, 1934, Serial No. 15, pp. 55-56.

better control obtained by farmers who follow its recommendations. The number of growers who received the spray service increased from 80 in 1931 to 2,410 in 1933. From 50,000 to 70,000 acres of potatoes were represented by farmers enrolled in the spray service in 1933.

The spray service is probably of most value during seasons of late blight epidemics. Great benefits, however, also are obtained in years of little disease. One of the chief values of this spray service is to make farmers "spray conscious." The individual farmers become better spray students and develop a keener interest in their spraying procedures with a resulting better disease control.

THE INFLUENCE OF INHERITANCE AND ENVIRONMENT ON THE MILK PRODUCTION AND BUTTERFAT PERCENTAGE OF JERSEY CATTLE*

This paper presents a study of the inheritance of milk yield and butterfat percentage in about 14,000 Jersey Registry of Merit cattle. The records of production are all of 364 to 366 days in length and are corrected to the production expected at maturity as judged by the cows' record obtained at another age. Parent and offspring, grandparent and offspring, sistership and cousinsip correlations are presented. These correlations show that inheritance accounts for about half the observed variation in milk yield and four-fifths of the observed variation in butterfat percentage. The environmental variations which exist in these Jersey records account for little of the variation in the butterfat percentage and for only 10 per cent of the variation in the milk yield. Dominance, assortive mating, and environmental variation common only to the cow herself account for the rest of the fluctuations in the yields and butterfat percentages.

MAGNESIUM DEFICIENCY IN AROOSTOOK POTATO SOILS†

The addition of magnesium to potato fertilizers prevented the stunted and chlorotic appearance which had been observed on potato

* This is a summary of a paper by John W. Gowen having the same title and published in the Jour. of Agr. Res. 49:433-465. 1934.

† This is an abstract of a paper by Jos. A. Chucka having the same title and published in Amer. Potato Jour. 11:29-35. 1934.

plants in many fields of Aroostook County. The increase in yield due to the addition of magnesium to the fertilizer varied greatly with the farm and season. The results obtained from the use of magnesium in different amounts and from various sources indicate that 20 to 30 pounds of magnesium oxide per acre produces the greatest increases in yield and that soluble sources of magnesium are somewhat more effective than dolomitic limestone in potato fertilizers for preventing magnesium deficiency. If the need of prevention has not been known, correction of magnesium deficiency may still be very largely effected, and yields may thereby be increased by applications of magnesium either to the soil or to the plant, even after magnesium deficiency symptoms have developed on the potato plants. The use of dolomitic limestone as a liming material on magnesium-deficient soils is recommended as the most practical method of correcting magnesium deficiency.

METEOROLOGICAL OBSERVATIONS

The Station is indebted to the Department of Physics of the University for the meteorological summary for 1934 which appears on the following page.

The instruments used are located on the University campus at Lat. $44^{\circ} 54' 2''$ N., Long. $64^{\circ} 40' 5''$ W. Elevation 135 feet. They are the same as those used in preceding years and include: maximum and minimum thermometers, rain gauge, self-recording anemometer, vane, and barometers. The observations at Orono now form an almost unbroken record of sixty-six years.

METEOROLOGICAL SUMMARY FOR 1934
U. of M. Orono, Maine

1934	January	February	March	April	May	June	July	August	September	October	November	December	Average	Total
Highest temperature	46	44	61	76	84	88	91	92	90	72	69	59	---	---
Lowest temperature	-27	-27	-8	20	30	31	46	40	38	25	16	-9	---	---
Mean temperature	16.51	13.45	23.33	45.28	56.46	61.44	68.98	63.65	61.35	45.61	39.68	18.51	43.27	---
Mean temperature in 66 years	16.53	13.04	30.14	39.36	51.01	61.29	67.14	65.70	60.19	40.20	37.11	23.00	43.31	---
Total precipitation in inches	3.86	3.90	1.53	4.85	1.49	5.64	4.23	2.69	5.61	3.45	3.08	3.17	---	43.55
Mean total precipitation in 66 years	3.86	4.13	3.65	2.86	3.23	3.44	3.45	3.45	3.50	3.96	3.51	3.55	---	42.69
Number of days with .01 inch precipitation or more	10	5	6	8	6	9	8	7	9	9	10	6	---	93
Snowfall in inches	20.75	24.50	3	---	---	---	---	---	---	---	.5	6	---	54.75
Mean snowfall in 66 years	21.19	21.25	13.73	5.41	---	---	---	---	---	.71	5.93	15.37	---	83.69
Number of clear days	12	20	13	15	21	13	19	17	10	12	11	14	---	182
Number of partly cloudy days	8	4	6	8	4	6	7	9	10	8	4	9	---	83
Number of cloudy days	11	4	7	7	6	11	5	4	10	11	15	8	---	99
Average wind velocity in miles per hour	4.79	3.92	5.05	5.04	4.75	4.01	3.20	3.67	3.50	4.54	4.51	4.14	4.26	---

REPORT ON THE FINANCES OF THE STATION

The Station is a department of the University and its accounts are kept in the office of the Treasurer of the University. The books, voucher files, etc., are, however, all distinct from those of the other departments of the University. The classification of accounts is that prescribed by the auditors on the part of the Federal Government, and approved by the State Auditor. All of the accounts may be audited by the State Auditor, and the Hatch Fund, Adams Fund, and Purnell Fund accounts are also audited by the Office of Experiment Stations acting for the Secretary of Agriculture of the United States in accordance with federal law.

The income of the Station from federal and state appropriations for the year that ended June 30, 1934, was:

U. S. Government, Hatch Fund.....	\$15,000.00
U. S. Government, Adams Fund.....	15,000.00
U. S. Government, Purnell Fund.....	60,000.00
State of Maine, Mill Tax, Other Income, Sales, etc....	38,355.10
State Department of Agriculture.....	12,386.02
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Total Income.....	\$140,741.12

The cost of maintaining the laboratories for the inspection analyses is borne by analysis fees and by the State Department of Agriculture. The income from sales at the experimental farms and the poultry plant is used for the expense of investigations. The cost of printing the Station bulletins is paid by the University from funds other than those mentioned above.

At Aroostook Farm there are in connection with the coöperative work with the Federal Department of Agriculture certain expenditures for the Department made from sales of crops from Department investigations. These expenditures are not included in the tabular statements. They are carried as distinct and separate accounts, always with credit balances on the Station ledger.

REPORT OF THE TREASURER FOR THE YEAR ENDING JUNE 30, 1934
DISBURSEMENTS

	Federal Funds			State Funds		Total
	Hatch	Adams	Purnell	Mill Tax, Other Income, Sales, etc.	Inspections	
Salaries	\$ 8,450.00	\$15,000.00	\$36,186.07	\$ 4,950.96	\$ 9,495.00	\$ 74,082.03
Labor	1,154.12	-----	7,280.13	11,181.43	1,800.52	21,416.20
Stationery and Office Supplies	422.52	-----	575.66	41.80	-----	1,039.98
Scientific Supplies	70.95	-----	794.03	170.39	210.05	1,245.42
Feeding Stuffs	415.85	-----	1,818.19	961.90	-----	3,195.94
Sundry Supplies	168.43	-----	736.08	3,502.47	24.91	4,431.89
Fertilizers	32.60	-----	1,682.43	8.85	-----	1,723.88
Communication Service	426.98	-----	33.00	217.42	114.28	811.68
Travel Expenses	826.63	-----	2,393.48	1,251.58	-----	4,471.69
Transportation of Things	120.26	-----	370.96	1,948.92	102.46	2,542.60
Publications	115.45	-----	23.00	77.82	-----	216.27
Heat, Light, Water, and Power	1,276.87	-----	1,178.55	2,793.80	482.76	5,732.98
Furniture, Furnishings, and Fixtures	80.42	-----	1,107.70	200.31	31.81	1,420.24
Library	1,195.98	-----	112.36	106.21	12.00	1,426.55
Scientific Equipment	69.37	-----	1,473.70	160.16	56.18	1,759.41
Livestock	27.30	-----	255.40	585.00	-----	867.70
Tools, Machinery, and Appliances	65.28	-----	3,650.86	1,826.83	-----	5,542.97
Buildings and Land	46.28	-----	166.54	2,679.65	49.29	2,941.76
Contingent	34.71	-----	140.86	3,501.20	6.76	3,683.53
Total	\$15,000.00	\$15,000.00	\$60,000.00	\$36,166.70	\$12,386.02	\$138,552.72